# AUDIO ENGINEERING

MAY
1951
35c

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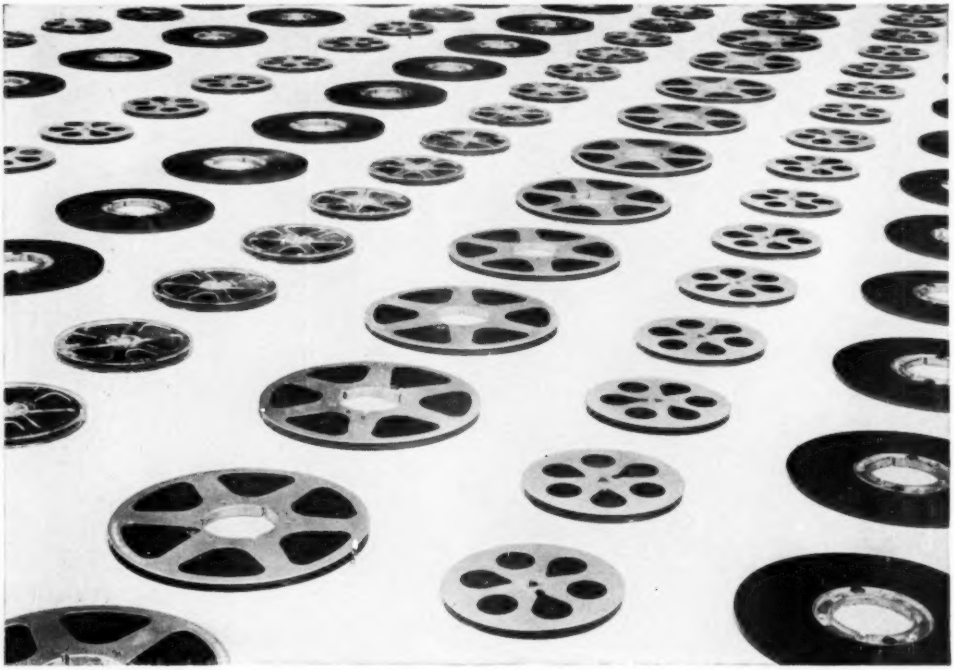

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# AUDIO ENGINEERING

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Established 1917

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### COVER

Our cover this month was prepared with design engineers in mind. Its purpose is to emphasize the end result which should always be the governing influence in the conception and manufacture of high-quality audio equipment for home music systems. Illustrated is the extent to which technical accomplishment must be coordinated with esthetic design, if a speaker is to be both acoustically correct and socially acceptable. The phantom picture, taken especially for Æ, shows the new Electro-Voice 4-way Patrician Model.


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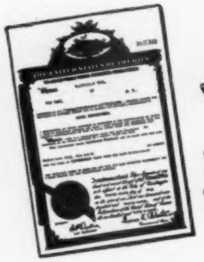


# AUDIO PATENTS

RICHARD H. DORF*

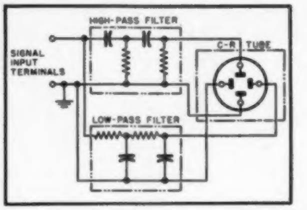



Fig. 1

Audio frequency measurement and spectrum analysis are not usually related in the same test instrument and the necessary equipment is usually far from simple if there is to be any accuracy to speak of in the work. A new patent has come to light, however, which puts both processes in the hands of any worker owning an audio generator and an oscilloscope, and having about fifteen minutes of time to put together what is needed. Rarely is it possible to get so much for so little, which is why this patent set fire to the writer's imagination (a fairly flammable one at any time, to tell the truth).

The patent is numbered 2,541,067 and the inventor is Edwin T. Jaynes, who has assigned the rights to The Sperry Gyroscope Corporation. To sneak up on the idea, let us remind readers of the common method

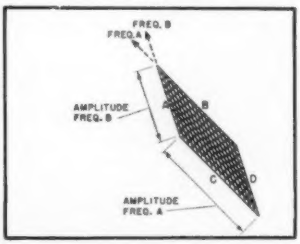



Fig. 2

of testing an audio amplifier for phase shift, in which outphased signals taken from a test generator and from the amplifier are fed respectively to the horizontal and vertical terminals of the scope. If there is no phase shift (or if it is 180 deg.) the pattern will be a straight line which, theoretically, should be leaning at a 45-deg. angle. The "theoretically" has been thrown in to good purpose—to remind you that the line leans at 45 deg. only if the signal level on both sets of deflection plates is the same. Actually, by playing with the deflection amplifier gain controls we can make the angle anything between the horizontal and the vertical. Ordinarily that doesn't matter since we usually judge phase shift, when there is some, by the width of the ellipse that appears, compared to the long dimension of the pattern.

Mr. Jaynes, however, puts the varying angle idea to excellent use by employing the circuit of *Fig.* 1. The signal to be measured is connected to the paralleled inputs of a high-pass and a low-pass filter. The filter outputs are connected to the two sets of c-r-tube plates. Now, if the product of the resistor and capacitor values in one filter is

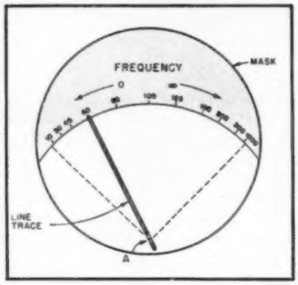



Fig. 3

equal to the product of those values in the other (meaning that both filters have the same cutoff frequency) the outputs will always be 180 deg. out of phase and a single line is always produced on the sceen. The angle of the line, however, will vary with frequency. At higher frequencies, for example, the input to the horizontal plates is low and that to the vertical plates high. Since the vertical component dominates, the line becomes more nearly vertical. The angle of the line varies with frequency, so it is possible to calibrate the angular rotation from zero to 90 deg. directly in terms of frequency? Once the two networks have been put together, there is almost no possibility that the calibration will be upset, since the indication depends entirely on the ratio of the output levels, not at all on the input level or on anything else.

But the true beauty of the idea is yet to come. It is possible to measure two frequencies simultaneously—or as many as there are, actually, if there aren't too many to make them all difficult to see. Two simultaneous frequencies produce a four-sided light area on the screen which can be anything from a square to a thin diamond, but in any case a parallelogram, like that in *Fig.* 2. The angles of the sides indicate the two frequencies. For example, sides *A* and *D* are parallel, and so are sides *B* and *C.*

**Audio Consultant, 255 West 84th Street, New York.*

The angles to be noted are indicated by the dashed extensions of sides *A* and *B*, though of course *C* and *D* could be used as well. If more than two frequencies are present, the figure is an *n*-sided polygon, with two parallel sides for each frequency. Thus the number of frequencies equals *n/2*. The angles of the sides with the horizontal are used for the measurements, just as with one- and two-frequency figures. Obviously this is a first-class spectrum analyzer for waveform analysis, harmonic distortion measurements, and so on—just as long as sufficient signal is available to enlarge the sides enough for observation. The length of each side is a direct indication of its voltage level.

The inventor suggests one solution of the practical problem of calibration indication, shown in *Fig.* 3. He rotates the c-r tube on its axis 45 deg. so that the range of "horizontal" to "vertical" position of the line on the screen is as indicated by the dashed lines. Then he places an opaque, crescent-shaped mask over the top of the screen (shaded area in the drawing) and writes calibrations on it. Then, with the aid of d.c. voltages in series with the filter outputs, he positions the no-signal beam spot at the position marked A. For single-frequency measurement the affair resembles an ordinary meter, with the line trace acting as the pointer.

So much for the patent itself and on to a few additional touches from here. For the setup of *Fig.* 3 (and for any other way of using this system) there is no reason for not using an ordinary scope and putting the signals from the filters through the usual deflection amplifiers rather than straight to the plates. Even if the amplifiers are dissimilar enough to produce slightly elliptical "lines" at very high and very low frequencies, the disadvantage is small, though appreciable difference in frequency response does not contribute a thing towards accuracy.

A calibration idea that seems a bit more practical for simultaneous measurement of several frequencies is to prepare a transparent mask of acetate to go over the face of the c-r tube. Lines are drawn on this mask somewhat like those of *Fig.* 4. Each radial line emanating from point A shows the angle of one frequency. Now, whether the pattern is a single-frequency line or a multi-frequency polygon, the line or side to be measured can easily be moved into position with the usual scope positioning controls alongside the radial line whose angle most nearly matches it, and the frequency read off from the calibration figures.

The arcs, drawn in equidistant steps from A as a center indicate voltage levels so that the level of each signal present can be compared to that of the others by measuring the lengths of the lines or the sides of the polygon. The mask must initially be made, of course, with the aid of a calibrated oscillator. If the oscillator is around all the time, it can be used, each time the scope is converted to a frequency meter, to recalibrate by feeding in a known frequency and adjusting the amplifier gain controls for the correct reading. Alternatively, a small, one-frequency phase-shift oscillator could be built into a small metal box with the filter networks.

Just to see what would happen the writer took ten minutes out in the lab to set up the circuit of *Fig.* 1 using 15,000-ohm resistors and 0.1-μf capacitors. Quick computation showed that the cutoff frequency was around 100 cps. It was found that reliable indications could be had over a frequency range of about 20 to 1. Ideal operation was from 30 to 600 cps but the actual operating range

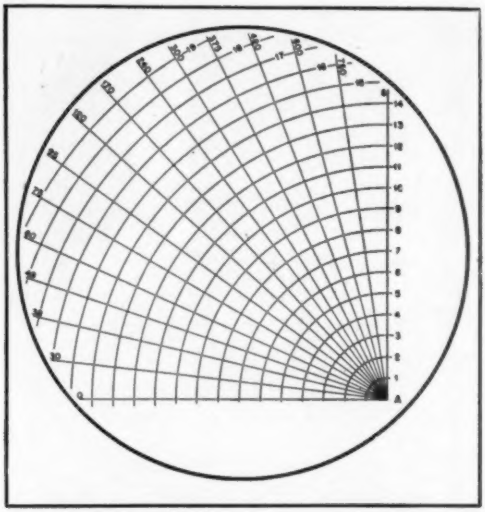


Fig. 4

could be shifted a fair amount by deciding just what frequency to use when setting the gain controls for a 45-deg. line. The components were only 20-per centers and the phase difference at the two inputs was not exactly 180 degrees, but the slight ellipse caused no trouble at all. As indicated in *Fig.* 3, the inventor claims that a 100-to-1 range can be covered, but a look at the scale shows that the frequency change for the last few degrees on each end is so great that easy reading is not possible.

Limiting the range calibrations to something between 10- and 20-to-1 ratios makes for good accuracy. As much spectrum can be covered as the user desires by simply substituting different filters, with higher cutoffs, for higher-frequency ranges. Using a 10-to-1 ratio, which seems best, three ranges would cover 20 to 20,000 cps. Probably each filter should be designed for a cutoff at the frequency in the approximate geometric center of its range—for the 20 to 200-cps range, for example, the cutoff frequency might be about 60 cps.

**Safety Stylus**

We can't all own super-terrific-quality amplifiers and diamond-point pickups, but we ought to be able to feel that at least the pickup stylus will not damage the record grooves. Unfortunately, most styli do, for after the point wears it not only makes the music sound worse but it starts chewing grooves. William F. Smith of North Hollywood, Calif., has come up with an ingenious anti-chewing system in Patent No. 2,493,466, assigned to RCA.

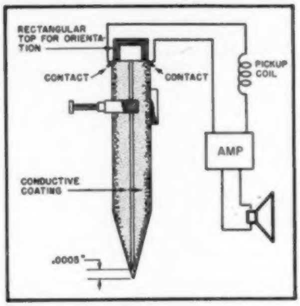



Fig. 5

His phonograph stylus is shown in *Fig.* 5. It consists of a nonmetallic body sprayed or otherwise coated with a conducting layer.

[*Continued on page 48*]

# TECHNICANA

A SIMPLIFIED CHART for the computation of the magnitude and phase angle of the forces acting at the throat of a horn is described in a paper by Josef Merhaut published in the *Tesla Technical Reports* for December 1949 at Prague, Czechoslovakia.

In horn-type loudspeakers, it is usual to have active areas of the diaphragm larger than the throat cross-section area. This causes phase delays between waves arriving at the center of the throat, and thus causes loss of power. To determine the actual loss of power, it is necessary to construct the force polygon for each frequency for a diaphragm of any given radius. This provides an approximate solution which may be made accurate by taking infinitesimal elements and integrating. The polygon then becomes a continuous curve. If several such curves are constructed for various frequencies and points of equal radius are joined, it is possible to obtain directly the force vector at the center of the throat.

The application may be extended to cover subdivided throats by the addition of the force vector for each throat division.

The power loss is the ratio of the force vector at zero frequency to that at the frequency being considered.

#### Phase Inverter

A novel cathode-coupled phase inverter is the subject of an article by Jaques Lignon in *T.S.F. Pour Tous* November 1950. The basic circuit for the phase inverter is shown in *Fig.* 1. An integral part of the circuit is the feedback connection to the second grid which, in the usual cathode-coupled circuit, is connected directly to ground. The feedback to this point eliminates the possibility of interfering with feedback networks in the preamplifier running from the plate of the preamplifier back, and includes an equalizing network. Also it permits the use of lower resistances than usually allowed because of the low-impedance voice-coil circuit, which it shunts, and the lack of limitation on the value of the grid resistor of the second tube section. Usually this value is fixed in other amplifiers by coupling considerations. With low resistance values, feedback is affected less by changes in temperature and humidity than with high values. A chart is provided for determining the value of $R$ for various available input levels. The two values given are for 20 db of feedback. Where it is desirable to substitute two 6SF5 tubes for the 6SL7 the plate load resistors should be reduced to 70,000 ohms each and the cathode resistor to 70,000 ohms.

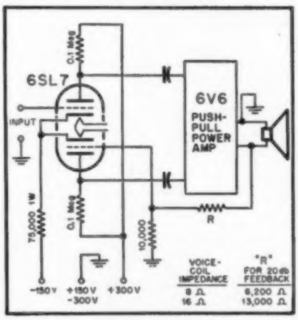



Fig. 1

The major drawback of this circuit is its use of the negative potential of 150 volts.

#### Stereophonics

J. Moir, in the March 1951 *Wireless World*, reviews the basic principles of stereophonic sound. There are five known important factors that appear to be the key indicators for the spatial localization by binaural hearing. They are the time delay between sounds as they strike the ears, the phase delay in repetitive sounds, the loudness difference between the ears, the sound intensity pattern due to diffraction, and, finally, the behavior of each ear when performing localization monaurally.

The spatial arrangement of an orchestra appears to be a desirable factor to carry over into sound reproduction. Study of two- and three-channel systems for this purpose indicates that the three-channel system gives excellent stereophonic quality to the reproduced sound, and the two-channel system provides a considerable improvement over a single channel.

To provide a stereophonic service in England, it is suggested that two of the simultaneous transmissions over different broadcast transmitters carry left and right sound signals, or that simultaneous uhf, or pulse modulation, could be employed to provide two- or three-channel signals. The use of the broadcast transmitters is immediately practicable in England. This would enable an improved quality in the received sound which is not attainable through the extension of the frequency-response range.

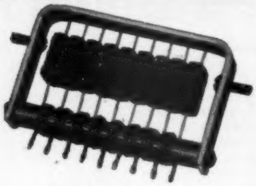
#### French Items

The November 1950 edition of *Toute La Radio* was a special export number which has much of the editorial material abstracted in English and Spanish. There are many articles in this issue of particular interest: stereophonic broadcasting of music, the automatic electronic switch, coil-block units, and background noise and sounds of continuous spectrum.

The article on stereophonic broadcasting details the techniques employed by J. Bernhart and J.-W. Garrett in broadcasting a program especially prepared for stereophonic broadcast under the direction of the well known director of French motion pictures, Rene Clair. The final equipment setup included two phonograph sources, three microphone channels, an echo chamber, and two tape recorders to prepare a left and a right stereophonic signal. The broadcasts

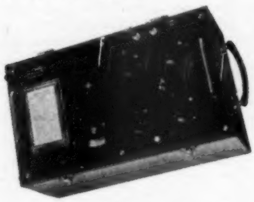
[*Continued on page 39*]

## *Something New*



### SPECIAL DELAY LINES

Lumped delay lines "tailored" to specific applications have been announced by the Shallcross Manufacturing Co., Collingdale, Pa. A typical unit consists of eight pie-section low-loss filters having a rise time of 0.04 microseconds and a total delay of 0.3 microseconds. Maximum pulse voltage is ± 100 volts and impedance is 500 ohms. Cutoff frequency is 8.5 megacycles and the maximum operating frequency approximately 2 megacycles based on a pulse delay error of not more than 2%. The unit consists of eight universally-wound coils of 3-strand #41 Litz wire and nine low T.C. silver mica capacitors. Many other types can be supplied.



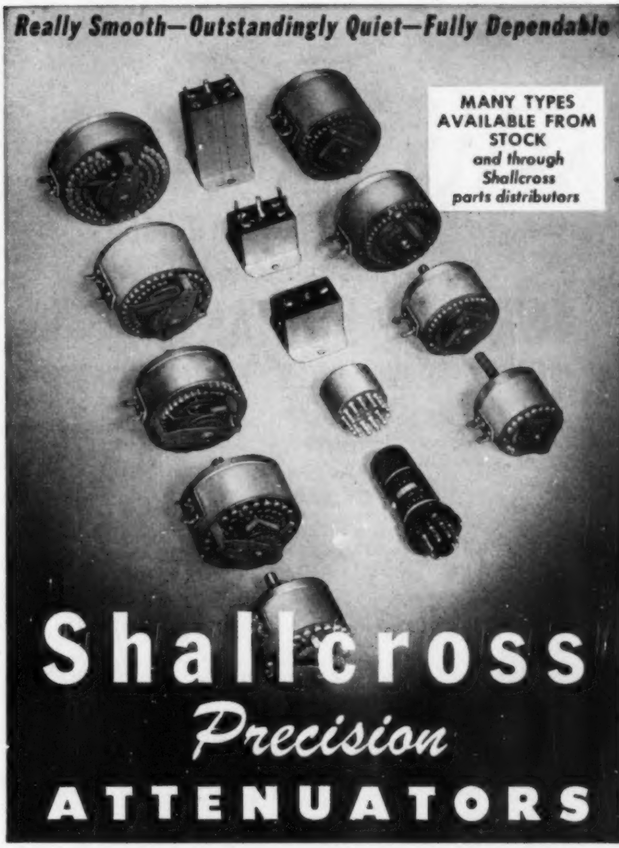
### NEW SHALLCROSS WHEATSTONE-MEGOHM BRIDGE

The new Shallcross 635-A Wheatstone-Megohm Bridge is a versatile direct-reading instrument for accurate measurements between 10 ohms and 1,000,000 megohms. It can be used to measure resistance elements and insulation resistance and to determine volume resistivity of materials. The instrument is basically a Wheatstone Bridge used in conjunction with a d-c amplifier. Two built-in power supplies operating on 115 volts, 60-cycles automatically provide the correct bridge voltages for the high and low ranges. Full information is available from the Shallcross Manufacturing Co., Collingdale, Pa.

### METAL-ENCASED RESISTORS

Flat, metal-encased, Type 265-A wirewound power resistors introduced by the Shallcross Manufacturing Company, Collingdale, Pa. are space wound, have mica insulation, and are encased in aluminum. At 175° C. continuous use they are conservatively rated for 7½ watts in still air and 15 watts mounted flat on a metal chassis. Write for Bulletin 122.

*(Advertisement)*

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**RESISTORS—INSTRUMENTS—SWITCHES—ATTENUATORS**

# LETTERS

**Re: Shortages, 5U4G's**

Sir:

Methinks Mr. Cone is trying to put a very large tempest in a very small bottle. In the welter of asininity that we are pleased to call 20th Century civilization, the availability or lack thereof of 5U4G's holds but little import. As emergencies go, this is a small one, and if it should fold, any one of a number of others could be whipped up on a short notice.

Val Adams,
Box 14,
La Jolla, California

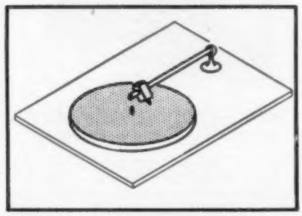
**Re: Patents**

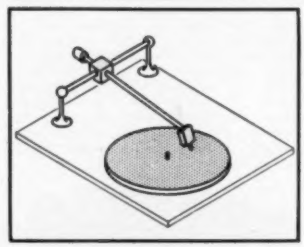
Sir:

At last Æ has its comic page, with clever imitations of Rube Goldberg's output. Coppleman's device described in the Patents column for March "solves" a complicated problem with super complications. Seriously, how can you swallow a pickup arm with six pivots, a rack and gear, and a yoke? And don't forget that you will need still more friction points for a compensated counterbalance.

If "good enough bearings" and proper balance were provided, you would have a pickup arm without tracking error, but there would still be side pull, depending on record speed and amplitude of recording.

Let's go back to "some contraption resembling a recording lathe." Drawings

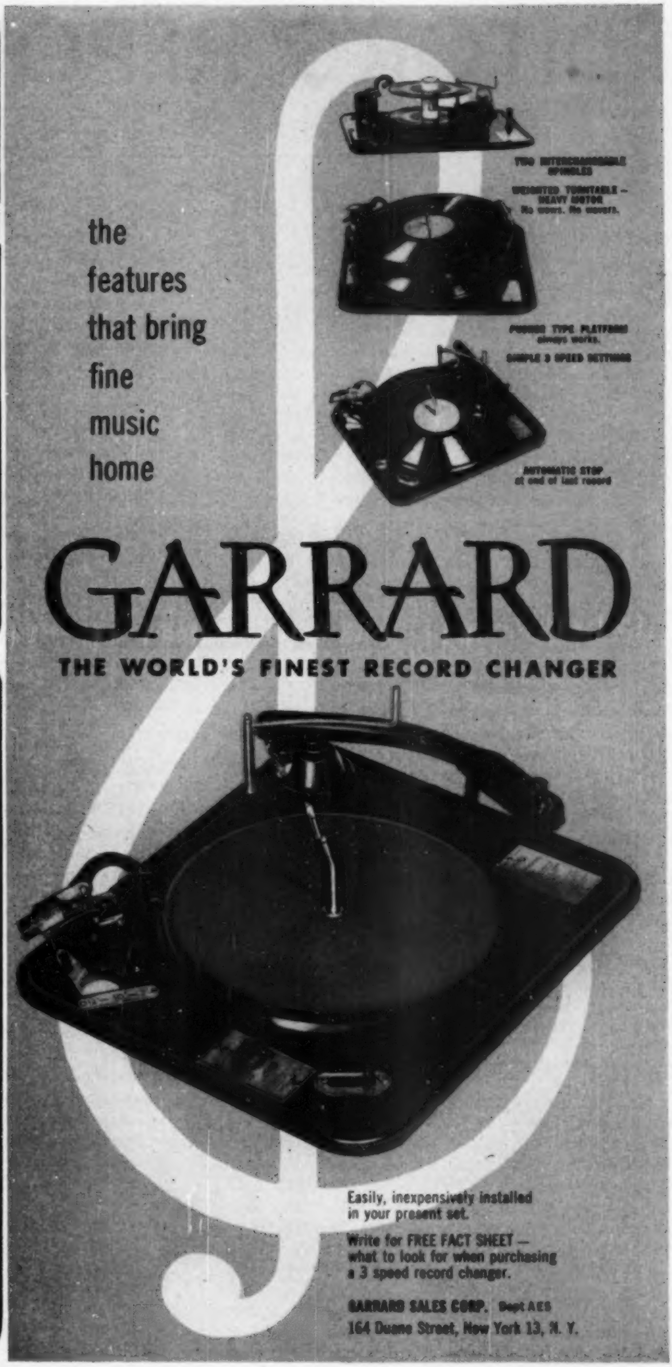




show two possibilities which feature the pickup travelling along a rigid wayrod. Any bearing manufacturer could design a trouble-free running device with little difficulty.

John E. D'Errico,
1243A 23rd St.,
Santa Monica, California

*(No reader is constrained to buy or use such a device as Coppleman's, even if it should ever reach the market, which is doubtful. Ed.)*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# EDITOR'S REPORT

## NARTB CONVENTION

CHICAGO, APRIL 18. The twenty ninth annual convention of the newly named National Association of Radio and Television Broadcasters offered a variety of technical papers which covered many of the current problems of broadcasters—both in radio and TV. Particularly interesting to the audio men in attendance was W. Earl Stewart's talk on "Trends in Audio Equipment," which compared early studio equipment with that currently in general use, and delineated the reasons for the gradual shift in type and appearance of the equipment. Mr. Stewart's paper was illustrated by a number of slides showing the differences in a way which left no detail to the imagination.

Most of the papers at the Engineering Conference dealt specifically with transmitter operation and maintenance, and with many aspects of TV—of growing importance in view of the possible "thaw" of the long freeze which has hamstrung the growth in TV stations for the past two years.

Harold Fellows, president-elect of NARTB to take office on June 4, outlined in one sentence what is needed for a broadcaster to achieve a position of leadership in its community. He said, "The progressive, intelligent use of a franchise to 'get a grip on' the community, to serve that community and its needs culturally, civically, *and commercially* is as worthy and should be as relatively profitable in Sunshine Valley, New Mexico, as it is in New York City."

That many broadcasters have not learned this basic principle of success and service is well known to any one who has spent a week listening to their offerings. FM broadcasters, as a class, have "carried the ball" culturally to a remarkable degree, particularly in the larger cities. Principal complaint of FM operators is that manufacturers have not kept up with the demand for FM receivers to the extent necessary for widespread popularity of this medium.

## SWITCH TO AUDIO

Since the beginning of radio, experimentation in the art has attracted the interest of young and old alike. In the 20's, it was common practice to build radio receivers rather than buy them because it was possible to obtain better performance than could be secured from commercially available apparatus. Since those days, radio receivers have improved immeasurably, particularly as regards sensitivity, stability, and reliability, so that today it hardly seems worth while for the experimenter to attempt to build a radio tuner. The design and construction of a tuner is fraught wth problems of tracking, of matching a tuning capacitor to a ready-made dial, of obtaining stability from a circuit on first attempt when small variations in stray capacitance can cause a large change in performance.

For these reasons, Æ has rarely offered any constructional information on tuners. It is felt that the cost of materials and the time expended in building a radio tuner does not represent sufficient saving over the cost of a factory-built tuner to warrant articles of this sort.

With audio equipment it is different. Many good amplifiers are commercially available, and good ones can be constructed even by a novice. The assembly and arrangement of equipment offers an interesting and satisfying pastime to the experimenter, and the infinite variety of speaker housings and complete-system cabinetry is limited only by the imagination and skill of the builder.

What is important, most of all, is that the individual interest in experimenting is rapidly swinging from radio to audio. As we see it, one reason for this switch is that the equipment built by the audio hobbyist is enjoyed by his entire family. He assembles a complete system—builds some parts, buys others ready-made—and he, his family, and his friends all enjoy the result. The radio amateur, on the other hand, is likely to shut himself off from conversation with others in his own household—becoming practically a hermit—while he alone enjoys his hobby.

This switch to audio as a hobby is a healthy one, and one in which we feel we have had a hand. One definite indication is that jobbers are exhibiting a widening interest in this new market, with more and more outlets featuring new and modernized sound departments. Æ has spearheaded this switch and will continue to offer material which can be relied upon. This has been Æ's aim over the past four years, and at the beginning of its fifth year, this credo is reaffirmed.

## VISITOR FROM ENGLAND

We are pleased to have again had the opportunity to compare notes with W. S. Barrell, Managing Director of Electrical and Musical Industries, Ltd. (EMI), who spent a few weeks in the New York area recently. As outlined in Mr. Canby's column, we were privileged to hear a number of microgroove tests which may or may not presage the entry of EMI into this field. Be that as it may, one thing is becoming more apparent as time passes—it is increasingly difficult to distinguish good recordings from live programs.

Obviously, this is as it should be. The crucial test of an adequate recording job is that the listener should not be conscious of the recording medium, but should—as Mr. Canby says—hear "through" the recording to the original. When that is achieved, a recording may be said to be a re-creation.

# PICKERING

## RECORD PLAYING EQUIPMENT

## *For flawless reproduction of the works of the masters*

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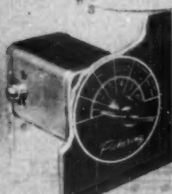

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# Ultrasonics in the Loran Trainer

PHILIP D. STAHL*

**Part 1. Beginning the description of a unique device used for classroom training of personnel in the operation of loran navigation receiving equipment.**

LORAN is the modern electronic method of navigation by which navigators of aircraft or sea vessels can determine accurately their geographical position by day or night. Loran can also be used for "homing"—following a predetermined line of position. Loran is a term which was derived by combining the first two letters of LOng, the first two letters of RAnge and the first letter of Navigation.

The accuracy with which these positions may be obtained is dependent upon the distance between the aircraft or ship and the land-based loran transmitters, but in general, results can be expected which are comparable to positions obtained by conventional celestial navigational methods. Loran service permits the accurate determination of positions at distances from shore or land up to 1400 miles at night and 750 miles by day. The reason for the difference is that ground waves are used by day and sky waves by night. Such ranges are achieved by employing relatively low frequencies of operation—specifically, between 1900 and 2000 kc. This band was chosen for greatest reliability consistent with maximum transmitting range.

Loran transmitters are on duty 24 hours a day throughout most of the world's major air and sea lanes. The ultimate requirements for covering most of the earth's traveled routes are estimated to comprise a total of 70 transmitting stations. Most of these units are either built or in the process of being constructed at this time.

The basic principle involved in the operation of the loran system is the reception of two radio signals, each of which is radiated by a different transmitting station. Using a loran receiving set, an operator is able to measure the elapsed time between the arrival of the first and second signals. The difference in the time of arrival of the respective signals bears a direct relationship to the difference in distances between the navigator and the two transmitting stations. Since radio signals travel at a constant speed, a direct relationship between time of travel and distance traveled exists. Consequently, measurement of intervals of time is, in essence, a measurement of distance itself.

The transmitted signals emanate from high power transmitters in the form of pulses approximately 40 microseconds

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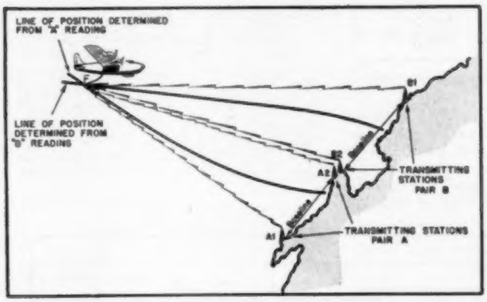
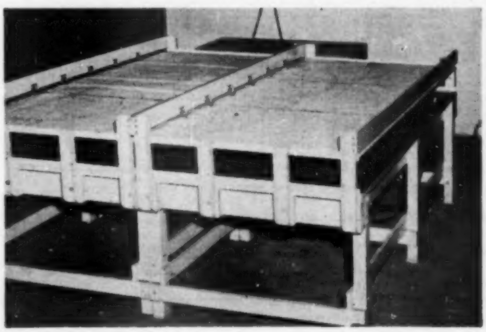
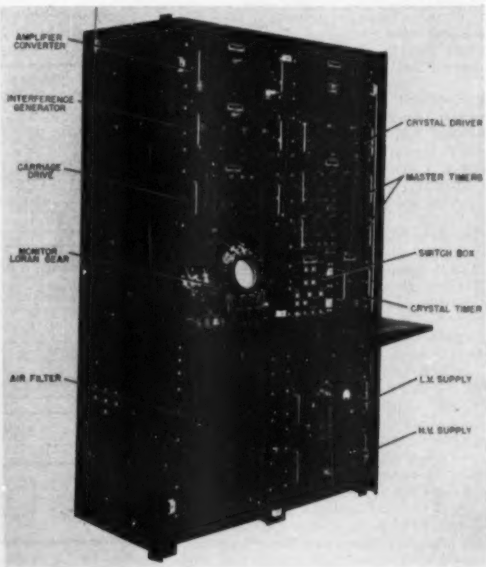



**Fig. 1 (left). Navigator aboard loran-equipped plane at "F" establishes "fix" by determining two lines of position "A" and "B" by loran measurements. Line of position "A" is found by measuring the time difference between signals received from transmitting stations A1 and A2. Line of position "B" is found by measuring the time difference between signals received from transmitting stations B1 and B2. The navigator's fix is established at the point of intersection of the two lines of position. The latitude and longitude of the navigator's position is determined from the loran data by using either loran charts or loran tables.**

**Fig. 2. Loran Trainer installation. Below, trainer table with chart on top surface which represents the ionosphere. "Crab" travels on masonite-covered platform below chart, and indicates its position by a light beam projected upward from center of transducer. Right, control cabinet for the Loran Trainer.**





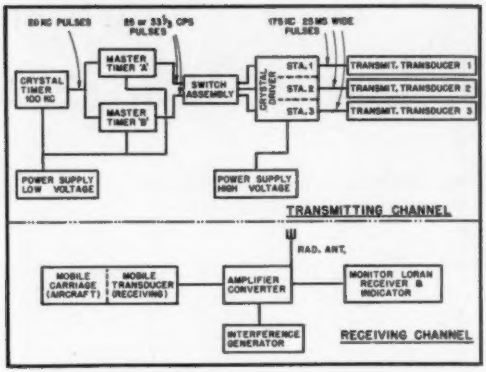



**Fig. 3. Block diagram of complete Loran Trainer.**

mately 40 microseconds wide, with the recurrence rate related to either of two bases, 25 or 33 1/3 per second.

Because the basic loran measurement evaluates the *difference* in the distances between the navigator and each of two fixed transmitting stations and not the individual distances themselves, there are many points at which the difference would be the same in spite of the fact that the distances themselves varied greatly. These points fall along a hyperbolic curve which is designated as a loran line of position. It is therefore clear that when a navigator obtains a reading from a particular pair of transmitting stations, he determines that his true position lies at some point on a particular loran line. By obtaining a loran reading from a second pair of stations, a second line of position has been identified and the navigator's true position or "fix" has been established at the point of intersection of the two lines.

Because loran is concerned with the measurement of signals from two separate sources, for purposes of identification, loran stations operate in pairs. The individual stations of a pair are designated "master" and "slave". These names are descriptive of the functions of each station. Specifically, the master starts the cycle of transmissions by sending a 40-microsecond pulse at 1950 kc. (channel 1 of the loran system) which is radiated unidirectionally. The signal is received by both the navigator and the slave station. After travelling the distance between the master and slave station, known as the baseline, the slave receives the signal and uses it as a time reference for the transmissions of its own signal. After the slave transmits its pulse the entire cycle becomes repetitive.

In order to provide the greatest possible number of loran station pairs and provide a foolproof method for distinguishing between pairs based at different geographical locations, two basic repetition rates, namely 25 and 33 1/3 cps, have been established. There are eight different repetition rates associated with each of the base frequencies or a total of sixteen possible repetition rates. Stations operating on the lower time base are pulsed at the rates of 25 cps, 25 1/16 cps, 25 1/8 cps, 25 3/16 cps, etc. through 25 7/16 cps while the higher time base stations are pulsed at 33 1/3 cps, 33 4/9 cps, 33 5/9 cps, 33 2/3 cps etc. through 34 1/9 cps. Thus, with a choice of sixteen different repetition rates it is a relatively simple matter to identify geographically any unknown loran pair of stations received on the equipment.

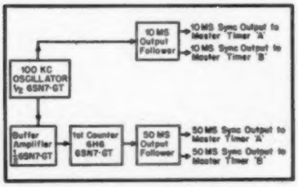



**Fig. 4. Block diagram of crystal timer unit.**

To simplify the navigator's problem of interpreting the loran data in terms of latitude and longitude coordinates, loran charts prepared by the U. S. Hydrographic Office are provided, which depict the "electronic lines" of position with respect to a particular map of the region in which the aircraft or ship is located.

To summarize, the loran system consists of three elements: (1) A series of land based loran transmitting stations; (2) receiving and time measuring equipment (loran receiving gear) accessible by the navigator on plane or ship; and (3) loran plotting charts. *Figure* 1 illustrates the basic principles of determining position by means of loran.

#### Purpose of Loran Trainer

The trainer to be described was designed and built through the joint efforts of the Navigation Section of the Special Devices Center, USN, and the Presto Recording Corporation, which has been the sole producer of this equipment to date. The Loran Trainer enables otherwise difficult ground or classroom training of navigators and crewmen in the operation of any of the currently available loran receiving sets, and provides experience in observation of loran signals and in working navigational problems just as they would be seen and computed in actual service. It permits the training of comparatively large groups of students at one sitting without resorting to the use of aircraft or ship.

#### Description of Loran Trainer

A photograph of the complete trainer is shown in *Fig.* 2. (A) is a view of the trainer table, and (B) shows the control racks. The design of the trainer is based on the fact that the velocity of radio signals in air bears a constant ratio to the velocity of sound in air. Specifically, the velocity of sound in air at room temperature is approximately 0.186 nautical

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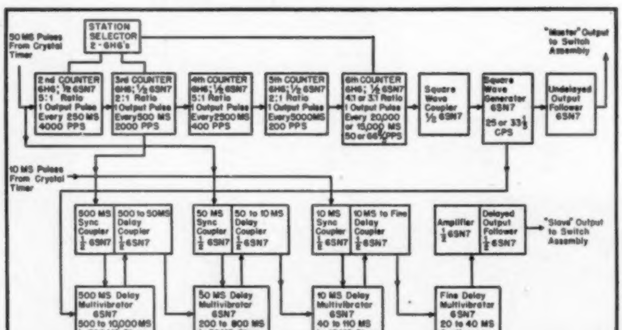


**Fig. 5. Block diagram showing stages of master timer unit.**

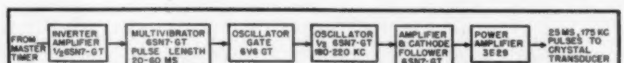


**Fig. 6. Block diagram of ultrasonic crystal driver unit.**

# A Survey of Audio-Frequency Power-Amplifier Circuits

PETER G. SULZER*

**A discussion of a number of amplifier circuits—both conventional and otherwise—along with the presentation of a "single-ended push-pull" amplifier.**

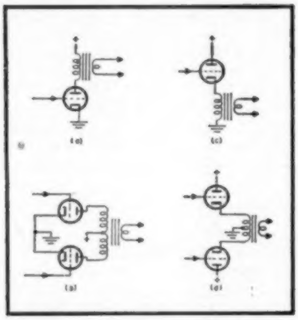

**Fig. 1. Conventional single-ended and push-pull output stages.**

IT IS THE PURPOSE of this paper to describe some circuits that are useful as audio-frequency power amplifiers. Although the use of several of the circuits in this application is uncommon, they appear to offer interesting possibilities of obtaining special characteristics. The discussion will be restricted to amplifiers employing output transformers since with present tube types it is economically impractical to obtain sufficient current to excite the voice coil of a loud speaker.

One of the first circuits employed as a power amplifier is that of *Fig.* 1(a), which is the plate-loaded, single-ended stage. The undistorted power output is comparatively low because class-A operation is required. The presence of d.c. flux in the output transformer is a disadvantage, as is the generation of even-harmonic distortion.

The push-pull circuit of *Fig.* 1(b) is an improvement, since the d.c. flux in the output transformer can be canceled. At the same time, class-AB or class-B operation becomes possible, as the tube characteristics are complementary. If symmetry has been attained, even-harmonic distortion will be very low.

These two circuits have been modified by the use of cathode loading, as shown in *Figs.* 1(c) and 1(d). Although the output impedance is decreased, no real advantage is gained that could not be obtained by employing inverse feedback.[1] In practice, distortion in an amplifier employing a cathode-follower output stage may be severe because of driver distortion which is the result of the large driving voltage required.

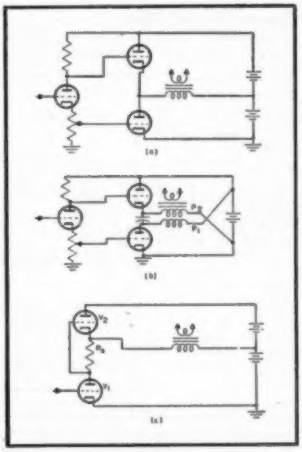

**Fig. 2. Series-balanced output stage arrangements.**

#### Two-Tube Arrangements

In devising other two-tube power amplifiers, the following considerations should be kept in mind: (1) d.c. magnetization of the output transformer should be avoided; (2) the tubes should be connected in such a manner that the production of even-harmonic distortion is minimized; and (3) the lowest practicable output-transformer turns-ratio should be employed; this may be accomplished by adding plate *currents* rather than plate *voltages* in the output transformer. The last requirement permits the use of a lower turns ratio, which is highly desirable from the standpoint of output-transformer design.

Considering a two-tube power amplifier, nine combinations are possible, as follows:

(1) Plates in push-pull, with grids driven in push-pull; (2) plates in push-pull, with cathodes driven in push-pull; (3) the push-pull cathode follower; (4) parallel operation with plate loading; (5) parallel, grounded-grid operation; (6) the parallel cathode follower; (7) plate loading of one tube and cathode

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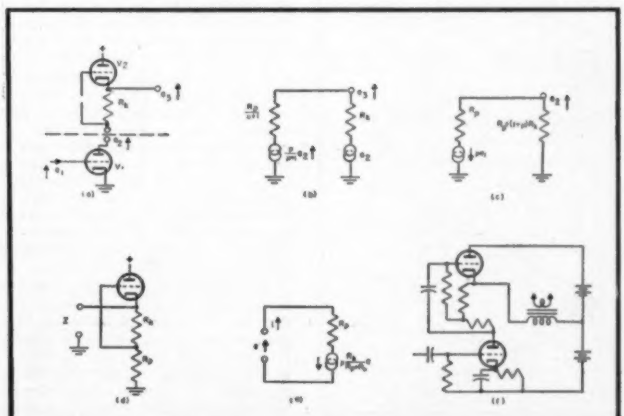


**Fig. 3. Equivalent circuits for analyzing the series-balanced output stage.**

[1] Howard T. Sterling, "The cathode follower as an audio amplifier," AUDIO ENGINEERING, p. 14, Dec. 1949.

* *National Bureau of Standards, Washington 25, D. C.*

# Design Elements for Improved Bass Response in Loudspeaker Systems

HOWARD T. SOUTHER*

**A frank discussion of the factors which influence the reproduction of low frequencies, and a description of means which may be employed to increase bass radiation.**

IT HAS BEEN SAID that music is the only form of dissipation which may be engaged in to any degree by the individual without harm to his physical well being.

Recognition of this postulate helps to explain the accelerating interest in quality sound reproduction as evidenced by the growing ranks of high-fidelity enthusiasts. This enthusiasm constitutes a profitable market for the manufacturer. Accordingly, acoustic research has been spurred recently to satisfy this demand. The listening public, lacking the objectivity of the engineer, has found it difficult to articulate its needs, thus making it hard for the engineer to direct his efforts with any degree of certainty towards a problem the solution of which is primarily subjective. As in the formative stages of any art, much of what has been accomplished in high-fidelity reproduction was through trial and error methods. Exploratory tests conducted by two well-known audio authorities may suggest the objective criteria so necessary to the engineer, and disclose some important points which previously have been overlooked by the lay listener. It is the purpose in what follows to indicate that the incorporation *of improved bass response in reproduced sound is probably the most important step* in the further development of the art.

* *Manager, Speaker Division, Electro-Voice, Inc., Buchanan, Mich.*

*This paper was presented on March 22, Audio Day, at the I.R.E. Show in New York.*

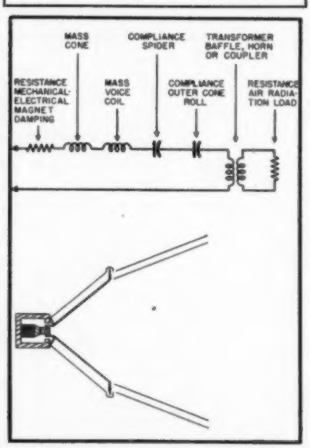



**Fig. 1. Typical loudspeaker and its equivalent circuit for investigation of design requirements.**

### Listener Reaction Tests

Howard Chinn of CBS conducted a series of listener tests using reproduced music. The general conclusion from this test was that listeners prefer a narrow, or at least a restricted band of frequencies.

This conclusion violated every aim of the idealist who instinctively believed his goal to be duplication of reality—including the reproduction of all frequencies between 16 and 16,000 cps.

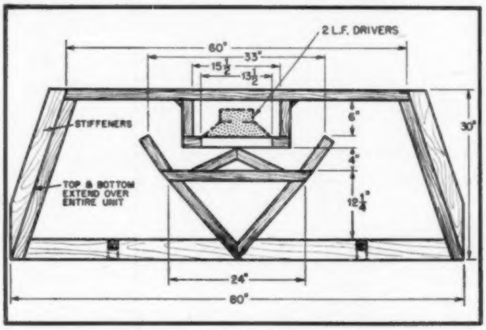
In refutation of the previous test conclusions, Olson of RCA employed a live orchestra with acoustic low-pass filters to test listener range preference. *The choice was incontrovertibly for the widest range response possible.* The discrepancy in test results was shown to be principally the result of odd-order distortions introduced by the electro-acoustical system. Narrow band reproduction subdued this distortion, making the sound more tolerable.

*An Indicated New Approach*—The rather conclusive tests by Olson show that the frequencies from 16 to 16,000 cps are necessary for ultimate listening. A concomitant conclusion is that the widest frequency range must be accompanied by very low odd-order distortion or the band must be restricted to be tolerated.

This last compromise cannot be reconciled by the progressive electro-acoustic engineer or he denies his reason for being. For sometime he has had virtually perfect wide-range reproduction in the laboratory, and has awaited only sufficient arguments to warrant presenting it to the public. The way to this presentation is paved by these facts:

1. *Public Acceptance*—The determination that the public desires high quality sound reproduction has been made. Note that this desire includes all the audible frequencies without balance from the bass range.
2. *Wide-Range Source Material*—New wide-range microphones, low distortion amplifiers, vinylite records, and magnetic tape will allow the wide-range speaker system to perform, sources no longer being a limiting factor.
3. *Treble Driver Units*—High-frequency driver units linear to 10,000 cps with less than 2 per cent harmonic distortion are available. "Super" high frequency drivers linear to 17,000 cps are obtainable. These are designed to supplement the average high-frequency driver.
4. *Low Speaker-System Distortion*—The principle of separating the driver units for reproducing only their respective portions of the spectrum reduces the transducer distortion to the region of acceptable limits.

**Fig. 4. Cross-section of theatre-type folded horn—the C-5 "bin."**




*The notable exception to the listing above is adequate bass in the reproducer response.* The goal of good listening in the home cannot be achieved without full consideration being given to the reproduction of the first three octaves up to 130 cps.

Consider for a moment that at 50 cps, a quarter wavelength is 80 in. In order to reproduce down to this frequency only, *just slightly below the third oc-*

*tave*, a horn 80 in. across the mouth is necessary. Thus, the usual claim of response to 40 cps would appear specious, to say the least, much less the sometimes added phrase of "useable response to 20 cps."

Further need for better bass response lies in the fact that the system is generally called upon to reproduce program music in the home at a much lower level than that at which it was originally recorded. Reference to the ear sensitivity curves of Fletcher and Munson show that the usual playback level of around 80 db leaves the bass attenuated by about 20 db. The best commercial amplifiers seldom incorporate more than 12 or 15 db of bass boost, for this equalization is costly of final overall power output, especially at the extremely low frequencies where the amplifier ordinarily finds some difficulty in meeting its specifications.

It can be incontrovertibly shown that good extreme bass response is necessary for music reproduction, even though the particular fundamentals involved are not included in the passages being reproduced.

This is explained through the fact that music consists to a very large degree of transient signals which seldom approach a steady state. Thus, staccato passages on a flute with a fundamental of 500 cps will not be reproduced with the proper envelope shape if the low-frequency interruptions of the fundamental tone are below the pass band of the speaker system. Moreover, the mathematics involved will show that for perfect reproduction of this same staccato flute passage the band should be *infinitely* low *and* high. For practical purposes, however, it can be assumed that distortion will be minimized, even on narrow band sources, if the pass band of the speaker is as wide as possible.

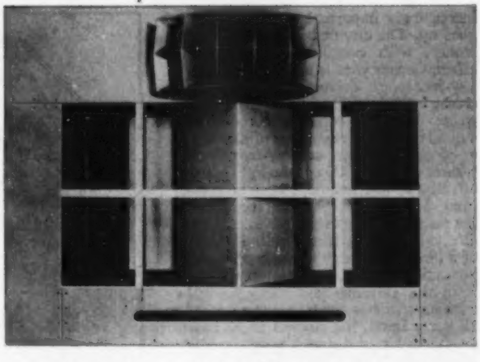


**Fig. 5. Front view of typical folded horn.**

It has been previously concluded that the widest reproducing range is important, and it may be assumed that the extreme low end of the spectrum in reproduced sound has been neglected. It is remarkable in view of the obvious and overwhelming importance of these low frequencies that so little has been done to accomplish this reproduction.

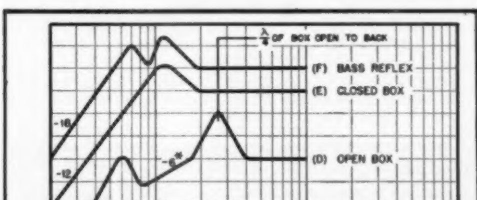
It is the purpose of the balance of this writing to disclose what *can* be done, and perhaps to point the way to the complete accomplishment of adequate bass.

**The Reproducing System**

A proper understanding of the reproducing system cannot be achieved unless we consider the elements with which we have to work. In Fig. 1, we observe these elements and the equivalent electrical circuit. For best comprehension of what is to follow let us discuss the items shown in the circuit one by one.

*(1) Magnet Damping (Mechanical-Electrical Resistance)*—In an electrical circuit, resistance will lower the "Q" and broaden the transmission band. Exactly the same thing transpires in the acoustic circuit. High magnetic damping results in fine broad band efficiency and subdues the natural modes of the vibratory system. There are other forms of damping which could be grouped along with this item. For instance, a shorted turn in the voice coil would provide this same sort of smoothing action, but at the expense of efficiency. Low internal impedance in the associated amplifier is of great value in providing this desirable damping action and accomplishes this without lowering overall speaker efficiencies.

*(2) Mass of the Voice Coil*—A short analysis of the equivalent circuit will disclose that voice coil weight becomes



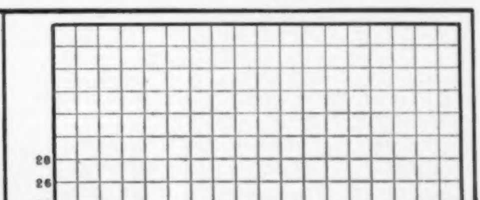




**Fig. 2 (left). Comparison low-end response obtainable from various types of speaker mountings. Fig. 3 (right) Optimum size of speaker enclosure for speakers of various diameters and resonant frequencies.**

increasingly important as the frequency goes up. The circuit becomes mass controlled, with compliances having less effect. Copper wire is used universally in low-frequency drivers because of increased conductivity irrespective of the weight disparity between it and aluminum. The higher resistance of aluminum is a disadvantage at low-frequencies, whereas, above 1000 cps the lighter mass offsets the disadvantage by a factor of some 35 per cent. At low frequencies, the mass of the cone and air load is little affected proportionately by the addition of 5 or 6 grams, due to the copper, with its attribute of high current capacity. It is in the extreme bass range that the current assumes high proportions. At 15 watts input, the current at 50 cps is on the order of 2 amperes in the voice coil.

*(3) Cone Mass*—Observation of the inductive element represented by the cone mass will lead the electrical theorist to assume that increasing the cone weight will lower the resonance and increase the bass range. This is correct, but an increase in cone weight of double the usual 25 grams will lower the resonance by only a few cps and decrease the efficiency by over 75 per cent. In a driver of top design using 5 lbs. of Alnico V, the iron of the structure is working at its economical limit, and this loss of efficiency cannot be made up in any practical way.

*(4) Compliance*—The next point of attack is logically the suspension system or capacitive element. The usual low-frequency driver has fairly stiff outer compliance rolls, as well as a stiff inner suspension, or spider. The reasons for this are quite practical. The resonance will naturally become lower if the compliances are increased. But here the manufacturer is faced with another dilemma. If he incorporates low compliances, the cone without adequate air loading will "bottom." This is caused by the voice coil hitting the flange on the nosepiece. In addition, non-linear response will ensue because of lack of restoring force when the voice coil rides out of the area of uniformly dense flux. A 30-watt rating for a driver becomes less than 3 watts when the suspensions are made more compliant without proportionately increasing the air load. But this, along with increased air loading, points the direction towards increased bass range and efficiency.

The average good 15-in. low-frequency driver has a free resonance of about 50 to 75 cps. Increasing the compliances reduces this resonance to about 35–50 cps. One 18 in. low-frequency driver on the market has a resonance guaranteed below 30 cps.

*(5) The Acoustic Transformer*—(4) above suggests that the operation of a driver unit cannot be treated on without consideration of its acoustic load. This load of very low impedance, i.e., the open air, must be coupled to the region of cone movement, an area of very high acoustic impedance. Considering the size of the wavelengths to be reproduced, we find that the "transformer" must deal in large surfaces and volumes. Hence, we must work with a baffle, box, and horn concept which is fundamentally architectural in nature. With no baffle at all a 15-in. speaker will begin to lose level from 800 cps down at the rate of 6 db per octave, as shown in curve (A), *Fig. 2*. This is due to the "doublet" effect of a dual radiator, for as the wavelength approaches the diameter of the cone, cancellation occurs because of the out-of-phase condition.

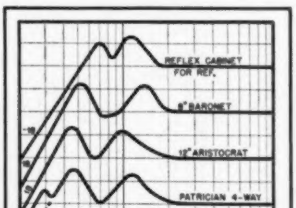



**Fig. 6. Typical response curves of reflexed cabinet, several manufactured enclosures, and the folded horn.**

### The Small Flat Baffle

Curve (B) represents a driver on a small baffle. Note that the "doublet" action takes place at a lower frequency, determined once more by the wavelength of the frequency being reproduced and its size relationship to the diameter of the flat surface.

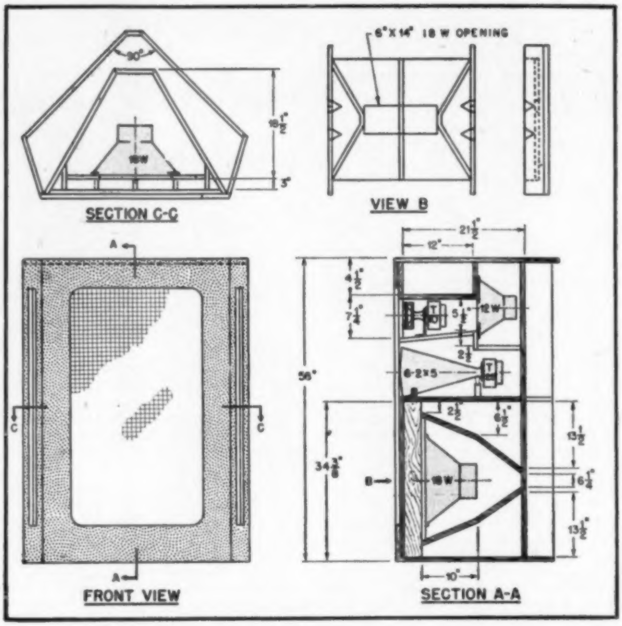



**Fig. 7. Simplified constructional drawings for the "Patrician" four-way system.**

### The Infinite Baffle

Continued increase in the size of the baffle involves another factor, however. If the baffle is large enough, or infinite, so that the critical frequency or wavelength of the diameter corresponds to the mechanical resonance of the driver, range response is extended to cone resonance, as shown in curve (C). But past the critical resonant wavelength of the driver cone, attenuation takes place at the rate of 12 db per octave, regardless of the size of the baffle. This is due to the stiffness, or low capacitive effect, of the driver cone mechanism, and indicates the value of a driver with low free-space resonance. From the practical aspect, it can be assumed that an 8-in. speaker with a free-space cone resonance of 62 cps will not benefit with a baffle larger than 5 feet in diameter.

### The Open-Back Box

Operating like the infinite baffle when the proportions are large, the open box is quite adequate provided that the dimensions prevent cancellation of the front by the back wave. However, in the usual dimensions suitable for a living room, say 6 to 12 cubic feet, the resonance of the box itself causes a violent peak of perhaps 10 to 17 db around 175

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# The I. R. E. Show

**A brief resume of most of the exhibitors' displays which would have been of primary interest to the audio field.**

**Retrospect** seems to offer the only sound means of evaluating events, such as the 1951 version of the annual IRE Show in New York, whose real values and accomplishments are more frequently than not submerged in the frills and excitement which reign from the moment the doors are opened for the first admission until they are closed for the final curtain.

If this year's show were to be reviewed superficially, there would be little need for anything more than assembling the usual group of platitudes which are used in "selling" such affairs to prospective exhibitors and to those who are expected to attend. With a quick switch in tenses, of course. For example and to wit:

"The 1951 IRE Show will be bigger and better than ever." It was. "Attendance is expected to exceed all previous records." It did. "A new high will be reached in the value of equipment on display." It was. "More manufacturers will be represented than in any previous IRE Show." They were.

In digging beneath the obvious, however, and in looking back on the show with the detachment of the third morning after, it can be seen easily that the exhibition was governed principally by three dominant influences—military, television, and audio.

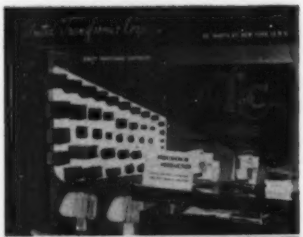
The Army, the Navy, the Air Force, and the National Bureau of Standards are to be congratulated on the intelligent assembly of one of the most interesting and informative displays of electronic equipment ever to be placed on public exhibition. Likewise, most of the equipment manufacturers are to be commended. And, speaking for the audio fraternity, the IRE Show management deserves blessings for apparent recognition of the fact that audio is a distinct entity in the field of electronics, and worthy of treatment as such.

This year, for the first time in the history of the annual IRE exhibit, audio equipment manufacturers who desired were assigned space in a special section of the exhibition hall devoted solely to the display and demonstration of sound equipment. Such an arrangement works to the advantage of exhibitors and visitors alike, and the audio brotherhood as a whole is grateful to the show management for this gesture of thoughtfulness.

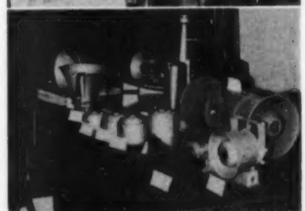
Herewith the reminiscent reflections of one foot-weary observer on but a few of the many fascinating exhibits:

**United Transformer Company** used the theme "Precision in Production" as a means of dramatizing the consistent high quality which is inherent in all UTC products. Displayed were many representative types of UTC transformers. Judged from the standpoint of planning and presentation, the UTC exhibit was one of the more inviting in the entire show.

**Magnecord, Inc.**, and **McIntosh Engineering Laboratory, Inc.** combined their facilities to produce a demonstration of great effectiveness in which a Magnecorder and three fifty-watt McIntosh amplifiers were used in conjunction with a Baldwin electronic organ and three Lansing Signature speakers. The demonstration procedure consisted of playing the organ live, then switching instantaneously to the monitor head of the Magnecorder, and giving individual members of a seated audience the opportunity of deciding which was which. The number of red faces gave eloquent testimonial to the fidelity of tape recording.

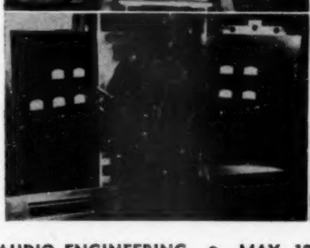







Right: United Transformer Company, Magnecord, Inc., University Loudspeakers, Inc., Racon Electric Company, Terminal Radio Corporation, Sun Radio and Electronics Company, Inc. Below: General Radio Company, Reeves Soundcraft Corporation, Sheldon Electric Company, Arnold Engineering Company.








**University Loudspeakers, Inc.** presented a display of speakers which was entirely fascinating. Great interest was shown in the new Model B-12, a super-power horn-type unit capable of continuous operation with a power input of 300 watts. Also coming in for more than average attention was an explosion-proof unit designed for use in atmospheres contaminated with explosive gasses. The exhibit was rounded out with other types ranging from tweeters for high-quality music systems to submergence-proof speakers capable of complete immersion in water without impairment of operating efficiency.

**Racon Electric Company, Inc.** featured a showing of loudspeakers of specific interest to engineers occupied with the installation and maintenance of p.a. systems. Cutaways of various models illustrated clearly the quality of construction for which Racon speakers are well known. High-quality-audio enthusiasts were not overlooked in the fact that the display included an improved version of the Racon tweeter assembly for two-way speaker combinations.



**Terminal Radio Corporation**, pioneer among New York's leading jobbers and distributors, displayed a variety of equipment ranging from TV chassis to magnetic tape recorders, however the overall emphasis of the exhibit was placed on Terminal's reliability as a source of supply. The backdrop of the booth was dominated by a large placard bearing the legend "Distributors are Known by the Products They Handle", and listing a large number of prominent manufacturers whose equipment is stocked by Terminal.

**Sun Radio & Electronics Co., Inc.**, one of America's most rapidly growing jobbers, introduced its new Electronics Parts Catalog, one of the largest independently-produced catalogs in the industry. Although located several blocks away from New York's famous "Radio Row", Sun has done a remarkable job of building up an enviable clientele in both consumer and industrial fields.

**General Radio Company** attracted a great deal of attention with an exhibit which emphasized the extent to which the GR line of test and measuring equipment had been broadened in recent years. Old-timers particularly, many of whom were virtually weaned on GR test equipment in the early days of radio, had their eyes opened by the growing variety of precision instruments with which GR is still maintaining a position of leadership in its field. Improved models of Variacs also came in for their share of attention.

**Reeves Soundcraft Corporation** attracted great interest with a showing of Magna-Stripe, a movie film on which is placed a sound track of oxide to permit magnetic tape recording either before or after the film is processed. Revolutionary in many respects, Magna-Stripe is expected to effect economies in the TV-film field by eliminating many of the expenses

**Far left:** Standard Transformer Corporation, Tech Laboratories, Inc., Amperex Electric Corporation. **Left:** Radio Corporation of America, Par-Metal Products Corporation. **Below:** Partridge Transformers Ltd.

inherent in optical recording. Also displayed with effectiveness were the Reeves lines of magnetic tape, discs, and picture tubes.

**Sheldon Electric Company** created great interest with the only showing of an instrument designed for production testing of TV picture tubes. Adding to the effectiveness of the exhibit was the fact that the tester was displayed in operation, and visitors were permitted to manipulate it under the guidance of Sheldon officials. The instrument affords complete evaluation of a picture tube's characteristics within minutes after the tube is placed in its mounting.

**Arnold Engineering Company** did a remarkable job of building an interesting display around such inanimate items as cores for toroidal coils and small samples of permanent magnets. Intelligent arrangement of the various alloys on exhibit, together with carefully prepared signs to coordinate the overall effect, effectively brought out the underlying reasons for the company's leadership in this field.

**Standard Transformer Corp.** used its display to accentuate the company's position as one of the country's leading manufacturers of transformers for all types of electronic application. In addition to building transformers for use in original equipment, Stancor is now supplying distributors with a comprehensive line of replacement items. A recently-published Stancor catalog, for example, lists replacement transformers for more than 900 TV receiver models.

**Tech Laboratories, Inc.** captured the interest of broadcast engineers with a display of the Artificial Reverberation Generator. Developed by Audio Facilities Corporation, although manufactured and marketed solely by Tech, the ARG affords considerable economy by eliminating the need for costly echo chambers. In operation, it permits simulation of any desired echo effect through use of an endless magnetic tape in conjunction with an amplifier and controls. Both the degree of reverberation and the decay time are adjustable. Tech also had an impressive display of precision attenuators for operation at frequencies as high as 100 mc.

**Amperex Electric Corporation** built its exhibit around a new high-power transmitting tube. Said to be the highest power air-cooled tube in the world, the new Amperex type AX9906R/6078 is capable of power output up to 108 kw. It embodies a new patented air-cooling principle exclusive with Amperex.

**Radio Corporation of America** had its usual lavish exhibit which featured a wide variety of RCA products for industrial application, as well as several recent developments of the RCA laboratories. Among the former were operating demonstrations of the RCA industrial TV system, and of the RCA electron microscope. Included in the latter category was a cutaway of the RCA color-TV picture tube. Means were provided for observing the color-dot arrangement under magnification which greatly increased the effectiveness of the showing. Another source of unusual attention was a well-executed scale model of the TV-FM tower assembly now being completed atop the Empire State Building in New York. For the sake of the record, and particularly because these words are appearing in AE, it must be noted herewith that the exhibit also included a small panel on which loudspeakers were shown.

**Par-Metal Products Corporation'** display was of interest chiefly to electronic equipment manufacturers. Shown were metal cabinets ranging in scope from units suitable for small receivers to ones capable of accommodating complete transmitters or large p.a. systems. Especially noticeable was the trend toward improved appearance in the housing of professional equipment.

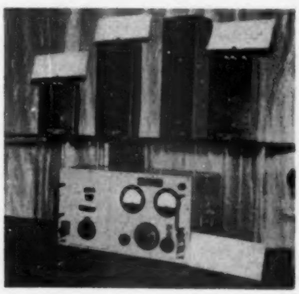
**Partridge Transformers Ltd.** made capital in its exhibit of the remarkable reputation achieved in this country by the Williamson audio amplifier circuit, the original model of which included a Partridge transformer in its design. Esthetic appeal has been considered along with constructiona features in the latest model Partridges, which are attractively finished in metallic brown.

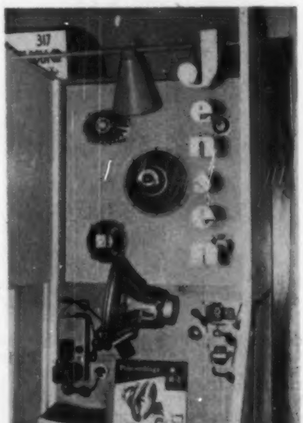
**The Daven Company's** exhibit was of interest chiefly to audio engineers. Daven has branched out considerably within the past two years and, in addition to the precision attenuators for which the company has long been noted, is now supplying engineers with an extensive line of assembled instruments for test and development applications. Principal among these items are a new distortion and noise meter, an output power meter, a frequency meter, in addition to a new series of r.f. attenuation boxes.

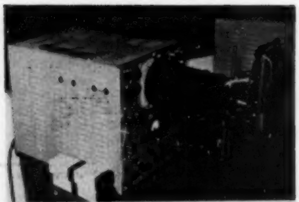
**Approved Electronic Instrument Corporation** covered the field with such diverse items as TV service equipment, audio amplifiers, and a recently introduced FM-AM tuner. Priced quite reasonably, it appears that this tuner may well be the means of bringing FM-AM reception of excellent quality within range of even the most modest income.

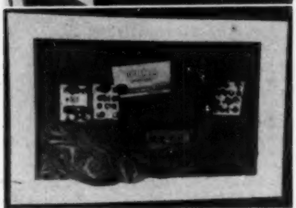
**Jensen Manufacturing Company**, although displaying a number of replacement speaker models, featured in its exhibit the new high-quality Type G-610 Triaxial. Many observers were noticed, upon leaving the Jensen booth, to strike a bee line for the sound room in which the G-610 was

**Below: The Daven Company. Right: Approved Electronic Instrument Corporation. Far right: Jensen Manufacturing Company, Panoramic Radio Products, Inc.**

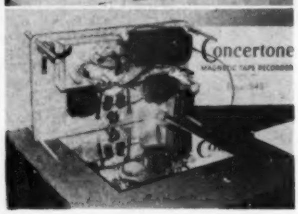


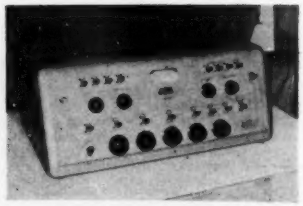









**Far left: Fairchild Camera and Instrument Corporation, McIntosh Engineering Laboratory, Inc., Gray Research and Development Company, Measurements Corporation. Left: Audio Devices, Inc., Cannon Electric Company, Fisher Radio Corporation. Above: Altec Lansing Corporation, National Company, Inc.**

demonstrated in conjunction with the Concertone tape recorder. This speaker, one of the newest developments in the audio field, came in for a great deal of attention during the entire course of the show.

**Panoramic Radio Products, Inc.** equipped its booth with several representative models from the extensive line of visual spectrum analyzers the company maufactures. Of more than usual interest was the working demonstration of the Ultrasonic Analyzer Model SB-7, shown performing as a telemetering system monitor.

**Fairchild Camera and Instrument Corporation** easily captured the interest of professional electronic engineers with a working display of the Fairchild-Polaroid Oscilloscope Camera. Using an audio signal generator feeding into a Textronix oscilloscope, booth attendants offered dramatic proof of the camera's effectiveness by photographing various types of wave shapes, then showing a finished positive print within one minute of exposure. The camera produces 3¼″ × 4¼″ prints with all traces recorded exactly one-half life size to facilitate comparison.

**Gray Research and Development Company** went overboard for TV with a unique demonstration of the CBS color system. The Gray exhibit on the first floor was used as the pickup point for a fifteen-minute program, presented two or three times hourly, which was transmitted by wire to a small auditorium on the third floor, where reception was by means of a group of receivers varying in picture size from twelve to fifteen inches. Interest in this demonstration was so great that the original plan of serving a seated audience had to be abandoned after the initial showing. Thereafter, viewers were kept moving slowly past the receivers in an effort to permit as many as possible to see the system in operation. The equipment used in the demonstration was designed essentially for industrial use and should not be confused with equipment intended for broadcasting which affords noticeably superior resolution.

**Measurements Corporation** used its display to keep uppermost in the minds of visitors the high degree of precision inherent in all Measurements products. Along with a colorful sign itemizing the various laboratory standards manufactured by the company, there was a display of the famous Type 80 signal generator, probably in greater use in laboratories throughout the world than any other instrument of its kind.

**Audio Devices, Inc.** came up with a unique device for attracting interest by using a sound room, not for demonstration of Audiotape and Audiodiscs as might be expected, but for the showing of a color movie made in the company's plant. The film was roughly fifteen minutes in length and carried the viewer through the entire manufacturing process involved in producing Audiotape. Showings were continuous throughout exhibition hours, and many hundreds of visitors were deeply impressed by the quality control applied at each step of production, resulting in the consistency of fine performance for which Audiotape and Audiodiscs are noted.

**Cannon Electric Company** graphically showed how its line of connectors had been expanded and improved to keep pace with the stringent demands of military equipment. Prominent among the items on display was the Type AN firewall connector, designed to prevent the spread of an aircraft engine fire through the bulkhead into wing sections. Other Cannon products shown were coaxial connectors for various types of r.f. transmission lines.

**Fisher Radio Corporation**, in addition to displaying the Fisher Custom Sixty FM-AM Receiver, engaged a sound room for a working demonstration of the Concertone magnetic tape recorder, for which it is Eastern distributor. This demonstration was particularly impressive because it employed, along with the Concertone, the new Jensen G-610 Triaxial loudspeaker system. For many visitors to the show, this was an initial opportunity to hear each of these items demonstrated in conjunction with equipment of comparable quality.

**Altec Lansing Corporation**, while displaying its extensive line of high-quality speakers, laid particular emphasis on the display of a new model audio console designed primarily for broadcast stations but equally well suited for use with high-quality sound distribution systems. Evident in this console is the trend toward reduction in bulk of studio control equipment. Evident also in the Altec display was the fact that loudspeakers formerly manufactured by Western Electric



Above: Shallcross Manufacturing Company, Masco Sound Systems. Right: Barker & Williamson, Inc., Herman Hosmer Scott, Inc., International Resistance Company. Far right: Browning Laboratories, Inc., Presto Recording Corporation, British Industries Corporation, Gates Radio Company.

are now being merchandised as part of the Altec line.

**The National Company** featured a showing of its superb receivers. Of principal interest to audio engineers and hobbyists is the new National high-quality FM tuner.

**Shallcross Manufacturing Co.** effectively called attention to the great expansion which has taken place in its line of products in recent years. Along with selector switches and decade boxes for which the company has long been noted, Shallcross now produces a wide range of precision measuring instruments, also offers a custom building service for the development of instruments to meet unique requirements.

**Masco Sound Systems**, in addition to showing a variety of phono amplifiers and p.a. equipment, featured a new and greatly improved model of the Masco tape recorder. The fact that Masco's reputation for aggressive merchandising is not entirely undeserved, is well illustrated in the manner with which this new tape recorder is being introduced to the trade. Compact and tastefully designed, it falls in the modest price bracket.

**Barker & Williamson, Inc.** centered the interest in its exhibit in improved models of B & W test equipment and in the wide variety of coils and components which the company manufactures as stock items. Of unique appeal to audio engineers was the Model 400 distortion meter, an instrument which performs many of the functions of wave analysis usually expected only of units costing several times the 400's low price.

**Herman Hosmer Scott, Inc.** keynoted its exhibit around an acoustics-for-industry theme. Although the Scott dynamic-noise-suppressor amplifier was displayed, emphasis in the



Scott booth was centered in the Scott sound level meter, random noise generator, and other instruments produced chiefly for industrial application. Interesting to note here that Scott, along with a number of other exhibitors, used its booth as a sort of classified ad in an effort to recruit engineering personnel. Prominent in several displays were signs proclaiming the opportunities awaiting technicians on the exhibitors' payrolls.

**International Resistance Company**, faced with the problem of building a display around objects which it must be admitted are a bit on the inanimate side, did a job which was thoroughly commendable. Various types of IRC resistors and controls were mounted on a large backboard in such fashion as to be both interesting and informative. Exceptional interest was displayed by engineers in the new Type LP water-cooled resistor for high-power high-frequency applications, and in the new IRC Loudness Control for audio amplifiers.

**British Industries Corporation** introduced in its exhibit a newly-improved model of the famous Garrard record changer. Already widely accepted in this country the new Garrard plays standard, LP, and 45 r.p.m. recordings, and is exceptional in the low amount of motor-induced hum when equipped with low-level magnetic-type pickups. While interest in the Garrard changer came mostly from audio engineers, manufacturers and service men were deeply impressed by a display of Ersin Multicore three-core solder, another product distributed in the country by British Industries.

**Presto Recording Corporation** cre-




ated intense interest with the first public showing of its new low-cost tape reproducer Type TL-10 (see **New Products**). The TL-10 is a spool-and-head assembly for use with standard 16-in turntables. Using the turntable spindle for driving power, it operates at 7½ and 15 in. per second, and has sufficient output for plugging directly into speech input equipment. It will greatly enhance the economy of using tape by eliminating the cost of an entire recorder where only reproduction is required.

**Gates Radio Company** stressed the high quality and clean appearance of its broadcast equipment in an exhibit which featured an improved audio control console and an air-cooled 10-kw transmitter. Both items were displayed in such a manner that internal construction features were clearly visible, and engineers were deeply impressed by the fine, workmanlike wiring, and placement of components which afforded unusual accessibility for maintainence and tube replacement.

**Browning Laboratories, Inc.**, taking into consideration the professional aspect of the exhibition, placed empha-

[*Continued on page 56*]

# Industrial Survival Sound Systems

H. S. MORRIS*

**Describing a currently important application of sound systems with a new aspect of their use—personnel protection.**

THE VALUE of the Industrial Sound System to efficient plant operation has become a one-sided argument. Progressive Management agrees that the plant-wide sound system conserves payroll in many ways. The time-saving feature of paging facilities; centralized control of shift changes and rest periods; and music distribution for morale purposes and to stimulate production, are only part of the story. Personnel Managers have used the plant-wide sound system to broadcast skits on absenteeism, and these thought provoking burlesques have reduced absences noticeably. Department Stores have found that besides the things it was orginally purchased for, the sound system is the only way executives can brief hundreds of sales personnel just before the store opens on such subjects as courtesy, special sales, and many other things; and after the store closes they have found that music drives away the emptiness of vast floors and timid cleaning women no longer fear to work alone among the drop-cloth enshrouded counters.

It was World War II which gave the Industrial Sound System its first real acceptance when it was demonstrated that increases of as much as 15 to 20 per cent in production could be effected by the judicious programming of music during periods when employees commonly tend to slow-down.

Now, evidence has already begun to appear that our present war-preparation period is going to bring many more calls for plant-wide sound systems from companies which have not heretofore had such systems or which have inadequate systems. But this time the accent is on protection—protection of personnel in case of atomic attack.

This growing interest is by no means confined to industrial plants. Inquiries are coming in from department stores, office buildings, banks, newspapers; in fact from all types of commercial establishments which normally harbor appreciable numbers of employees or the public.

Recall World War II and the elaborate measures which were taken at that time along the lines of civilian defense. Many of us were air-ward wardens with tin helmets, flashlights, and sand buckets. And at that time, our enemy had planes that could barely span the Atlantic and there were no such things as jets, guided missiles, and atomic bombs.

### THIS TIME it will be Different

THEN—an attack would have consisted of TNT explosives with damage and personnel danger limited to direct hits.

Now—an enemy attack would be much more devastating and there can be no question of such attacks on many industrial centers if we should get into a fighting war with a major power. Instead of confined direct hit damage, the atomic weapon of the next war will strike crippling destruction over a surrounding area of several square miles and danger to personnel over a still wider area.

It is this new and much more terrible hazard to human life that extends far beyond and for an *uncertain time after* the actual strike that is building the demand for the Industrial Survival Sound System.

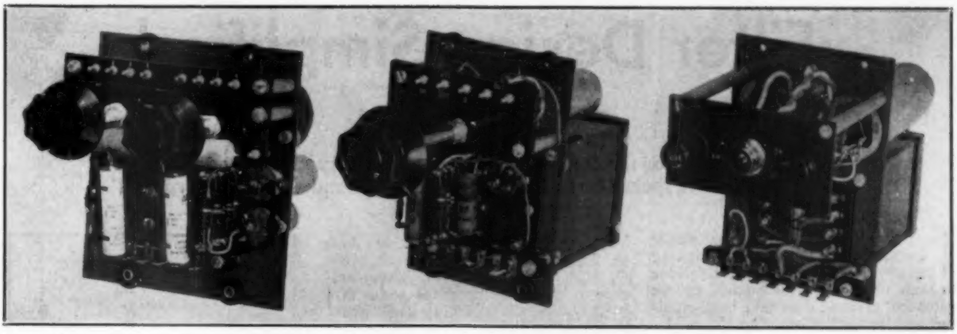
Sirens cannot do the job. They cannot reliably penetrate buildings, pierce common industrial noise levels, and alert persons with ordinary hearing defects. At best, sirens and alarms only *alarm*. The uncertainty which follows their use breeds panic and hysteria.

In contrast, the Survival Sound System makes it possible for a Plant-Protection Officer to give voice directions throughout the entire duration of an emergency. Not only can the Plant Protection Officer, in whom the employees are trained to have confidence, immediately alert all employees of an impending attack, but he can also direct various

* *Altec Lansing Corporation, 161 Sixth Ave., New York 13, N. Y.*

**(Right) Typical installation of speakers in department store. Square grilles in the false ceiling over the aisles show a few of the 850 high-quality 755A speakers in Hess Brothers Department Store, Allentown, Penna.**

**(Left) Where installation of speakers in the ceiling is impractical, small enclosures may be attached to the walls or ceilings without disturbing the decor appreciably, as shown in another view at Hess Brothers Department Store.**



(Left) Two-channel mixer preamplifier; (center) line amplifier; and (right) power supply. All of these units are designed for mounting directly on power amplifier chassis, although they may be located at some point remote from the amplifier if desired.

groups to different places of shelter; and should a nearby atomic strike actually occur he can give voice directions to all under his charge to remain in their shelters and take whatever precautions are wise until such time as the properly constituted authorities have determined that danger no longer exists due to gamma ray contamination or other conditions.

The Survival Sound System is the most valuable tool of the trained Plant Protection Officer. In case of atomic attack, carefully planned moves can be quickly carried out to the finest detail by means of running voice instruction calmly given.

#### Amplifier Equipment

Just three months after the opening of the Korean hostilities, Altec Lansing announced to the market a new 1400 series of amplifiers which were specifically designed to the foreseeable needs of what is now known as the Survival Sound Systems for personnel protection. The general amplifier requirements were compactness, great flexibility, economy of cost, simple installation. These requirements resulted in some unusual design features.

Two basic power amplifiers are provided, of 35 and 75 watt capacity, ample to cover floor areas of 25,000 to 100,000 square feet. These amplifiers have a total of 96 and 98 db of built-in gain, respectively, enough to operate directly from a low-impedance dynamic microphone, without the addition of a pre-amplifier. Thus, the cost of the simple Survival System with a single microphone input for small plants is low. Both amplifiers have master gain controls to complete the provisions for direct microphone inputs. Built-in high-pass equalization is provided to reduce bass response and to improve voice intelligibilty when it is necessary to cut through reverberation or high noise levels. Outputs are available for 70-volt speaker distribution as well as the usual voice-coil impedances.

Class AB design was selected to give longer tube life and to reduce power line consumption during periods of no signal or standby.

A small compact two-channel mixer pre-amplifier 1410A was designed for use where more than one input is required for additional microphones, wired music, turntables or other signals. The two-channel idea makes the cost of adding inputs very low. Again for compactness, the mixer pre-amplifier can be mounted directly on the power amplifier chassis. The 75-watt amplifier will mount two such pre-amplifiers, providing a complete amplifying system with four mixing inputs all in 14 in. of cabinet space. Up to six mixer preamplifiers (a total of 12 channels) can be powered by this power amplifier.

The preamplifier also has been designed to meet easily the infinite problems of remote mixing and control. The output of each of the channels in the amplifier is a cathode follower with an impedance of less than 1,000 ohms. Thus it can feed into a long line without introducing frequency errors. The outputs are combined in a network consisting of two potentiometers, two blocking capacitors and two building-out resistors. These components are arranged on a sub-assembly which can be removed from the 1410A and installed at some remote point where it is desired to control the system. No problems are involved in feeding the mixing network from the cathode followers and the network can be located as far as 400 feet from the preamplifier.

Input impedances are 30, 150/250, and 500 ohms, and by a slight RC modification one or both channels can be adapted to a variable reluctance pickup.

The 1400 Series of amplifiers is completed for all applications with a two stage Line Amplifier coded 1440A and a remote Power Supply coded 30A. Both units are of the same size as the Mixer Pre-Amplifier, 5 3/16 × 3½ × 6¾ in. In a space of only 5 3/16 × 19 in., a complete four-channel remote mixer to drive telephone lines can be made up of two mixer preamplifiers, a line amplifier and a power supply.

Simple arrangement typical of medium sized Survival Sound System with 75-watt power amplifier and 632A microphone for use by telephone operator, who connects her microphone by means of a foot switch.

[*Continued on page 37*]

# Filter Design Simplified

**BERTHOLD SHEFFIELD***

**Part II. Continuing the presentation of a method for calculating constants for filters, with special attention to band-pass and band-elimination types.**

In THE PRECEDING ARTICLE a simple method was shown for designing major filter types without reference to texts or charts. This method can be extended to band-pass and band-elimination filters, thus enabling the reader to design elements of the major filter types by applying simple, well known formulas.

In brief review, it was shown that T and Pi type configurations consist of identical L sections, whose two arms each have a reactance $X$ which, at cut-off frequency, equals the termination $R_o$. This conclusion holds for T and Pi, low-pass and high-pass filters, and is shown schematically in *Fig.* 1.

The configuration of the basic L sections of *m*-derived types differs somewhat from the constant-k section, but the magnitude of the reactances of the arms are directly related to the constant-k type. *Figures* 2 and 3 show L type *m*-derived half sections.

Band-pass filter half section elements are designed as readily as the low-pass and high-pass types. For example, in the band-pass half section of *Fig.* 4 each element in the series arm has the reactance $Q_oR_o$ at center frequency, while each element of the shunt arm has the reactance $R_o/Q_o$ at the center frequency $f_o$. $Q_o$ refers to the ratio of the resonant frequency $f_o$ and the bandwidth between half-power-point frequencies $f_1$ and $f_2$; i.e.,

$$Q_o = \frac{f_o}{f_2 - f_1} \qquad (8)$$

A numerical example will illustrate the application of these formulas. A brief proof follows the illustration, showing the validity of these statements.

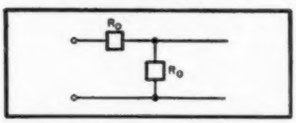



**Fig. 1. Basic L section showing element values of reactances at cut-off frequency.**

#### Numerical Example of Band-Pass Filter Design

Suppose it is desired to design a band-pass half section for an experimental noise suppressor of the type suggested by Dr. H. F. Olson, of RCA Laboratories. The bandwidth of the first octave is to be 1500 to 3000 cps, and the nominal termination of the half section is chosen as 6000 ohms. From this data the center frequency, $f_o$, of the filter is $\sqrt{1500 \times 3000}$ or 2,121.32 cps. Using formula (*8*), $Q_o = f_o/(f_2 - f_1)$, or 1.414. The reactance of each element of the series arm is $R_oQ_o$, or $6000 \times 1.414 = 8484$ ohms. Since the series reactances are equal at center frequency, $X = \omega_o L = 1/\omega_o C = 8484$ ohms. The elements are calculated by writing

$$L_1 = X/\omega_o = 0.636 \text{ henry}$$
$$C_1 = 1/(\omega_o X) = 0.00885\ \mu f.$$

The series and shunt arms are inverse, hence

$$L_2 = R_o^2 C_1 = 0.318 \text{ henry}$$
$$C_2 = L_1/R_o^2 = 0.0177\ \mu f.$$

The half section with these element values appears in *Fig.* 5.

#### Proof of Simplified Formulas

The midseries image impedance $Z_{IT}$ of the band-pass filter is derived from the same formula which applied to constant-k filters in the preceding article, namely

$$Z_{IT} = \sqrt{Z_1(Z_1 + Z_2)} = \sqrt{Z_1 Z_2} \times \sqrt{(1 + Z_1/Z_2)} \qquad (9)$$

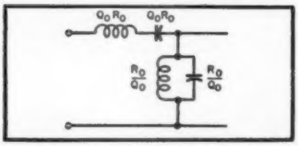



**Fig. 4. Band-pass filter half section showing element values of reactances at center frequency.**

The band-pass filter is to pass all frequencies between $f_1$ and $f_2$ and is to cut off below $f_1$ and above $f_2$. At the boundaries, $f_1$ and $f_2$, $Z_{IT}$ should be zero. That the first term, $Z_1Z_2$ cannot become zero at two frequencies is readily shown by noting that

$$Z_1 = j\left(\omega L_1 - \frac{1}{\omega C_1}\right) = j\omega_o L_1\left(\frac{f}{f_o} - \frac{f_o}{f}\right) = j\omega_o L_1 A \text{ and}$$

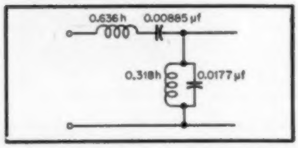



**Fig. 5. Band-pass filter half section for 6000-ohm termination and a bandwidth from 1500 to 3000 cps.**

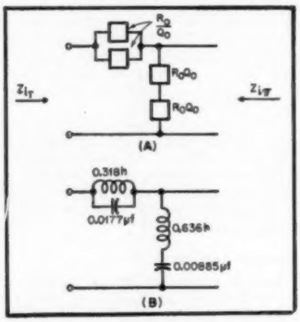



**Fig. 6. (A) Basic half section of band elimination filter showing element values at center frequency, and (B) with element values for $f_1 = 1500$ cps, $f_2 = 3000$ cps, and $R_o = 6000$ ohms.**

$$Z_2 = \frac{\omega L_2/\omega C_2}{j\omega_o L_2\left(\frac{f}{f_o} - \frac{f_o}{f}\right)} = \frac{1}{j\omega_o C_2\left(\frac{f}{f_o} - \frac{f_o}{f}\right)} = \frac{1}{j\omega_o C_2 A} = -\frac{j\omega_o L_2}{A}$$

$$\therefore Z_1 Z_2 = \frac{L_1}{C_2}$$

It is of interest that the last expression is identical in form to the expression (*7*) obtained in constant-k low-pass and high-pass filter analysis. The expression

$$Z_1 Z_2 = \omega_o^2 L_1 L_2 \qquad (10)$$

shows that $Z_1Z_2$ can be zero only at zero frequency—a trivial solution. However,

[*Continued on page 28*]

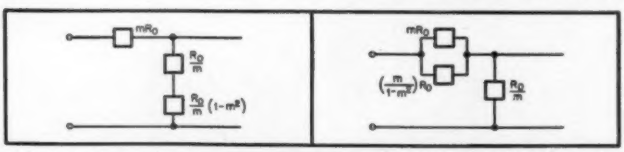



**Fig. 2 (left). Element values of reactances at cut-off frequency for series m-derived half section, and Fig. 3, (right), for shunt m-derived half section.**

* *RCA Institutes, Inc., 350 W. 4th St., New York 14, N. Y.*

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Illustrated with Blonde model M-253 cabinet showing accessory legs.

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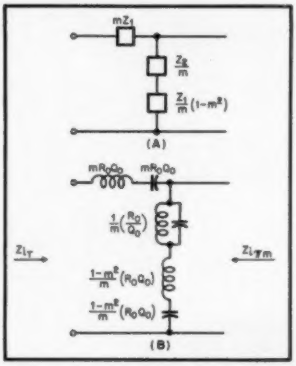


**Fig. 7. Series m-derived band-pass filter half sections: (A) basic half section, and (B) element reactances at mid-frequency.**

the binomial term of the radical $\sqrt{(1+Z_1/Z_2)}$ may become zero when the vector $Z_1/Z_2=-1$, and for this value of $Z_1/Z_2$, the image impedance $Z_{1T}=0$. When the ideal filter is thus terminated in zero ohms there results complete cut off.

### Determination of Center Frequency ($f_o$)

The expression $Z_1=-Z_2$ yields the value of the center frequency $f_o$ in terms of the band edges $f_1$ and $f_2$. It also yields an expression for the values of the inductors $L_1$ and $L_2$ and for the capacitors $C_1$ and $C_2$. Since $Z_1=-Z_2$,

$$j\omega_o L_1 A = -j\omega_o L_2/A, \text{ and}$$

$$A^2(L_1/L_2)=1, \text{ or}$$

$$A=\pm\sqrt{L_2/L_1} \qquad (11)$$

For any frequency below $f_o$, numerical substitution shows that $A$ is negative. Hence at the low frequency boundary $f_1$,

$$\frac{f_1}{f_o}-\frac{f_o}{f_1}=-\sqrt{\frac{L_2}{L_1}} \qquad (12)$$

Similarly at the high-frequency boundary $f_2$

$$\frac{f_2}{f_o}-\frac{f_o}{f_2}=\sqrt{\frac{L_2}{L_1}}=\frac{f_o}{f_1}-\frac{f_1}{f_o} \qquad (13)$$

Equating the frequency ratios produces the desired expression,

$$\frac{f_2+f_1}{f_o}=\frac{f_o}{f_1}+\frac{f_o}{f_2}$$

$$f_2+f_1=f_o^2\left[\frac{f_1+f_2}{f_1f_2}\right]$$

$$f_o^2=f_1f_2 \qquad (14)$$

This shows that the resonant frequency of either the series or the shunt branch is the geometric mean of the cut-off frequencies.

### Determination of Element Values

For convenience the filter is terminated in

$$R_o=\sqrt{Z_1Z_2}=\sqrt{\omega_o^2L_1L_2} \qquad (15)$$

At $f_1$ we obtain from expression (12)

$$\frac{L_2}{L_1}\left(\frac{f_o}{f_1}-\frac{f_1}{f_o}\right)^2=\left(\frac{f_o^2-f_1^2}{f_1f_o}\right)^2=\left(\frac{f_2-f_1}{f_o}\right)^2$$

$$\therefore \quad L_1=L_2\left(\frac{f_o}{\Delta f}\right)^2$$

Substituting for $L_2$ its value from (15)

$$L_2=\frac{R_o^2}{\omega_o^2L_1}$$ it is seen that

$$L_1=\frac{R_o^2}{\omega_o^2L_1}\left(\frac{f_o}{\Delta f}\right)^2$$

This leads to the final simple relation that at the center frequency $f_o$, the reactance of either of the series elements is

$$X_1=\omega_oL_1=1/\omega_oC_1=Q_oR_o \qquad (16)$$

The shunt elements are found in similar fashion, and the magnitude of either element of the parallel circuit at center frequency $f_o$ is

$$X_2=\omega_oL_2=1/\omega_oC_2=R_o/Q_o \qquad (17)$$

The last formula, (17), is usually not required because series and shunt arms

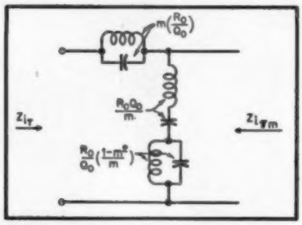


**Fig. 8. Series m-derived band-elimination filter half section showing element reactances at center frequency.**

are inverse. Thus the shunt elements are calculated from $L_2=C_1R_o^2$ and $C_2=L_1/R_o^2$.

### Band-Elimination Filter

A band-elimination filter is designed by interchanging the series and shunt arms as shown in *Fig. 6*. *M*-derived band-pass and band-elimination filters are employed where sharper cut off is desired and where the impedance characteristics must be more constant than with the constant-k types. The *m*-derived sections are constructed in the same manner as the low-pass and high-pass sections, *Fig. 7*. A band-elimination filter half section, series *m*-derived, is shown in *Fig. 8*.

Numerical substitution will show that the elements of the m-derived band-pass filter of *Fig. 7* are physically impractical. It is fortunate however that the entire shunt arm can be replaced by an equivalent parallel combination of two series connected LC circuits, *Fig. 9*.[1] The elements of the revised network, however, are not as simple as those of *Fig. 7*.

The band width between the two frequencies of infinite attentuation, $f_{1\infty}$ and $f_{2\infty}$, is found from

$$\Delta f_\infty=f_{2\infty}-f_{1\infty}=\frac{f_2-f_1}{\sqrt{1-m^2}}$$

$$\text{or } \Delta f_\infty=\frac{\Delta f}{\sqrt{1-m^2}}, \text{ where } \Delta f=f_2-f_1$$

For $m=0.6$ $\qquad \Delta f_\infty=1.25\,\Delta f$

If only $\Delta f_\infty$ is given, then $f_{2\infty}$ may be found from the equation

$$f_{2\infty}=\tfrac{1}{2}\left[\Delta f_\infty+\sqrt{(\Delta f_\infty)^2+4f_o^2}\right]$$

This and other relations are readily derived from

$$f_o^2=f_1f_2=f_{1\infty}f_{2\infty} \qquad (18)$$

An illustration will clarify the use of these equations. Assume it is desired to design a 2000-cps band-pass filter with $f_2=2050$ cps and $f_1=1950$ cps, and $R_o=1000$ ohms. For $m=0.6$, $\Delta f_\infty=125$ cps and $f_{2\infty}$ falls on 2062.5 cps. Hence $Q_o=f_o/\Delta f = 2000/100 = 20$ and $Q_oR_o = 20{,}000$. Also, $(f_o/f_{2\infty})^2=(2000/2062.5)^2=0.935$. The series reactances $mX_{L_1}=mX_{C_1}=mQ_oR_o=12{,}000$ ohms. The remaining calculations are straightforward as follows. The half section is shown in *Fig. 10*.

$$L_1=\frac{mXL_1}{\omega_o}=\frac{12000}{(2\pi)(2000)}=0.954 \text{ h.}$$

$$C_1=\frac{1}{\omega_o^2L_1}=0.0066\ \mu f.$$

$$X_{L_2}=X_{C_2}=\left(\frac{1-m^2}{2}\right)(Q_oR_o)\times\left[1+\left(\frac{f_o}{f_{2\infty}}\right)^2\right]=12{,}400 \text{ ohms}$$

[*Continued on page 58*]

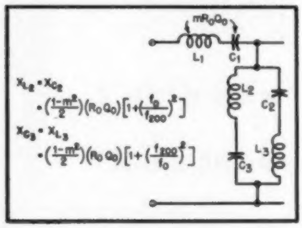


**Fig. 9. Band-pass filter half section, series m-derived, showing reactance values in terms of center and upper infinite cut-off frequencies.**

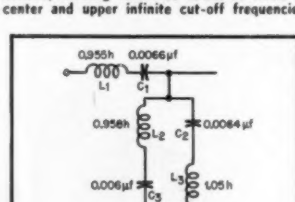


**Fig. 10. Band-pass filter half section, series m-derived, showing element values for $f_1=1950$ cps, $f_2=2050$ cps, and $R_o=1000$ ohms.**

[1] See, for example, T. E. Shea: "Transmission Networks and Wave Filters" D. Van Nostrand Co., New York


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EDWARD TATNALL CANBY*

## Batch of Tests

SPENT AN EVENING recently *chez* ye editor, listening to assorted music via his own pride and joy, the McProud Corner Speaker, TV and Flower Stand. (New form of entertainment: tune the TV department to the juiciest and goriest TV fight that you can find, then turn off the TV sound and turn on the phono— with the William Tell Overture or other appropriate music. If you want real fun, try getting a team of comedians on the screen and backing them up with Gilbert and Sullivan on the phono! One runs into some strange coincidences between action and music.)

The point of the evening, (and the reason for this disquisition) was the music we heard after the TV subsided and business was got down to. Business was represented, so to speak, in a purely social manner, by Mr. W. S. Barrell, a most genial Britisher who happens to belong to EMI, the enormous record company that runs HMV and Columbia and a batch of other companies in the record field, in Britain and the Empire and elsewhere.

As you may know, there are now LP records in Britain, as of last spring or summer. They come from Decca, known hereabouts as London. EMI is making 78's. The announcement went out recently that EMI would give the British phonograph industry six months' notice whenever a change was decided upon in the speed of records, and therefore Britain—the announcement not having yet been made—will remain essentially a 78 r.p.m. country for a good while yet. It's as though, here, RCA Victor, Decca, and Mercury, plus perhaps M-G-M and Capitol, were still sticking to 78's only, and Columbia were still on its own (like Decca in England) with LP.

### A Bit of Everything

Mr. Barrell brought with him a precious box of records. Tests, no less, experimental pressings of EMI music on slow speed. These tests he played to us. (There was of course a certain confusion because we were trying to judge the effect of the McProud System, complete with U.S. components, upon Mr. Barrell while he, natch, was busy fathoming our reaction to his records—and I, an outside listener, was trying hard to get used to the unfamiliar complex of acoustics, speaker, equalization, records, etc. in order to be able to react intelligently to about eighteen "unknowns" simultaneously!) We heard the tests, and I hereby react.

But first—don't look for any mystery, nor indeed a solution of the same. Yes, EMI has made test microgroove pressings. We heard 'em. EMI is doing what comes natural. Trying out a bit of everything. No commitments. Not for publication, anyhow, nor even for our inquiring private ears.

### Christmas, 1948?

But what must strike you at once, in the above description of the present situation in Britain, with only one major company producing LP's, as a pioneer ("we'll show 'em") venture, is that over there things are about at the Christmas 1948 level in this country. Columbia then was where British Decca is now, roughly speaking (with some notable differences in respect to tape recording of originals, of course). A single major company, a single company-sponsored popular player attachment (it's the Deccola in England, I gather), the other major companies watching on the side lines, experimenting behind the scenes, preparing for a later change, when and if.

And that, in more specific ways, was the reaction I got from hearing and seeing Mr. Barrell and his test records. I was, perhaps, not as enthusiastically impressed as he may have hoped for, and I surely apologize here for any

[*Continued on page 42*]

** 279 W. 4th St., New York 14, N. Y.*

# Pops

RUDO S. GLOBUS*

SEVERAL MONTHS AGO, I received a review copy of a disc that should have received nothing but meritorious praise. Featuring two worthy names and released by a large recording outfit, it should have sold in the hundreds of thousands. It fizzled completely! Generally, I am not overanxious to praise the record-buying public, a large group of people who would corrupt any business they poked their naive hands into. In this case, regardless of their motives, they justifiably stayed away from as clear a case of homicide as the recent history books contain. I did not review the disc because the policy of the column is to avoid, as much as possible, records which cannot be favorably reviewed, or which do not point to a significant moral.

But, lo and behold, the disc was used by a recording executive as a pointed reason for avoiding "high-class" pop recording. According to him, the public won't buy "hi-fi" pops, won't buy jazz names, won't buy good experimental stuff, etc. With a self-satisfied smirk, much rubbing of hands, and the healthy flush of a successful mortician, big wheel executive glibly dispensed with the necessity of any changes in the nirvana of pops recording. Pulling a quick switcheroo, he unremorsefully informed me that the American people know what they want and know what they like; if they don't buy an item, it's obviously because their judgment (their noble and sophisticated judgment) is superior to that of the minority of record critics who have been bombarding the industry with demands for this kind of thing.

In the first flush of early anger, I notified him that nothing on the disc vaguely resembled any of the stuff I've been screaming for. But, calming down and sticking my feverish temper back into the temper box,

[*Continued on page 32*]

** 15 Palm Lane, Westbury, L. I., N. Y.*

I unveiled my latent investigatorial ability and did a job. The results of the job were highly illuminating and are revealed in what follows. 'Tis a sad tale and a typical one. Pay heed, oh mighty big wheels!

First step in the criminal investigation involved tracking down the arranger who was theoretically responsible for the junk. The soft shoe routine revealed a friend who, surprisingly enough, is one of the most competent guys in the business. Over a dime beer and some moderately stale free lunch, he told the story . . . and what a story it is! Is it true? Friend arranger is a particularly honest guy, who gladly accepts responsibility for bad jobs as well as good ones. But even if he were covering up, past experience points to the typicality of the story.

It all began in the microcephalic head of one of the wonder boys of the business. (Incidentally, I will have to recreate the story to avoid giving clues as to the actual record involved. So don't try to guess! The particular session described is a mere figment of my imagination. Only the procedure is historically accurate.) This fancy ignoramus decided to bring together two big names in the business, record them together in a lavish production. The date would, in one respect, refute the claims that the pops business was being run by a bunch of rockheads; in another, it would demonstrate to the top echelon that melonhead was a financial wizard, a musical impressario, and a production genius. So, one day, friend arranger was called in and told to do big things for the two great people . . . told to really blow his top and let his creative imagination run wild. For two weeks, he did just exactly what he had been told to do. He figured that since both stars were small club personalities, the perfect arrangement would be subtle, intimate, scored for a small group with a tricky and supporting background.

Came the day of the session (lights, camera, faction)! The stars went through the arrangements and smiled the blissful smiles of contented cows. Their backing consisted of a six-man combo, every one of which thought the arrangements were great stuff. They ran through the business once. At this point all hell broke loose. Boy genius producer let out a shrill holler and cancelled the session. The arrangements were no good. What he wanted was something lush, something big . . . a production. All he got here was a six-piece band playing kid's stuff. He wanted a string section, a large wind and brass section, and none of this tank town recording, minus echo chamber, Theremin, tricky mike effects. The stars were too big for a two-bit recording date like this.

Friend arranger argued, the stars put up a feeble rejoinder. But, to no avail. How could they possibly be aware of what the public wanted. You have to make a buck, so friend arranger went home with a whole pile of manuscript paper and got to work on a production, with string section, French horns, tricky wind and brass effects, etc. A new date was scheduled and a large orchestra and a battery of engineers got together to turn out a slick, technicolor demon of a date, replete with the presence of the pin-stripe execs, a name conductor, and another arranger, called in to make last minute changes for which he is famous.

Before we go any further in relating this gory tale, a word about the two stars. Both were neither out-and-out jazz people or out-and-out straight pops. They specialized in a quiet, salon-type presentation which goes over especially well late at night under dim lights. Both were subtle in their work and had always relied on a piano and percussion patter to support their gentle im-

provisation. Both were (and are, incidentally) terifically good at their sort of thing, which requires a gentle and cultivated touch. What happened to them in this case is bloody. Overpowered by a giant orchestra and fantastic manipulation, they cowered. The engineers were called in and the usual stuff began happening. Instead of working together, one was placed at one end of the studio, the other in a corner by herself. The she of the story doesn't really sing, but quietly purrs. That wouldn't do. Boy wonder wanted a blast and so instructed the engineers. The he-star of the story, playing a delicate and gentle patter behind the vocal was muted out entirely because he crummed up the string background. The consultant arranger was, meanwhile, busily at work, slap-dashing the arrangement this way and that way. After five takes, the wonder boy was ecstatic. Several months later, the record was released, fizzled completely, and pretty nearly ruined the reputation of two marvelous people who were monstrously manhandled by a genius. The only critical comment that appeared noted that the engineer on the job had kept the strings "too far off in the background."

At the conclusion of the story, friend arranger smiled wanly and informed me that both stars and he are no longer on speaking terms. There's always a convenient fall guy, *N'est-ce pas?*

**Correspondence**

Off on another tangent, I have received a fantastic influx of mail from Texas which requires immediate and terse comment.

Beginning with the first letter to hit me from the grandiloquent state, let me emphasize, suggest, and rudely urge all controversy-minded readers that it is most advisable that they *read* the column before picking fights. First literary pugilist from Texas spent much time, much ink, and much paper in notifying me that everything I had to say about folk music was wrong and explaining why. I would like to slap back, but find after re-reading the letter that the slap would only mess up a batch of regular, ordinary air. Texas reader agrees with everything I have to say down to the last decimal point. My only conclusion is that he has either mis-read, not read, or dis-read the piece in question. I am in full, complete, agreement . . . to all obvious intents and purposes we have no folk music in this country. But mind that *obvious*. Our record literature and what passes as compendia of folk literature do not generally include any material which fits into the general category of "folk music." The synthetic stuff is mostly derivative from other national sources, or is merely the stylistic work of the craftsmen that abound on New York's 6th and 7th Avenues.

So what! We still have an enormous fund of folk music . . . except that it isn't operative on the sociological level that is characteristic of the folk music of other cultures. All this impressive sounding verbiage boils down to something as simple as what was originally indicated in the previous column. Until the country as a whole utilizes, becomes conversant with, and integrates the primordial folk music structure into an everyday, traditional, and practically instinctual cultural element, it lies dormant and inactive. The conditions of modern life preclude a non-mechanical process of integration and the repressions involved in the choice of our impressarios of material for dissemination cut off the folk literature at its source.

But . . . we have had a widely disseminated, active and pervasive folk-music literature. I point with pardonable pride at

the jazz phenomenon . . . an element of folk culture, despite the pretentiousness of the tie-in. One level of folk-music—if we particularize the term to include a structure as described above—has thoroughly permeated the national consciousness and is as closely related to the pattern called the "United States" as is the national pride in tall buildings. However, jazz is merely an element of the folk culture and not the folk culture itself. It tends to be too closely related and associated with a particular segment of the population, as is the case with Gypsy music in central Europe.

The true, broad, generic level of folk music is limited to other "vested" interests. Whether we refer to the folk music of the Blue Hills or the music of the Okies, or the music of the cowboy, or the music of the farmer, or what not . . . the problem of integration and national penetration remains. This was discussed previously, and it was suggested at that time that the only practicable method involved the use of recordings. I refer to that original for the details. I needn't rehash them!

Letter No. 2 from Texas concerned the problem of reaching the mass of the American people with jazz if, as I indicated, records are inadequate. I am in complete agreement with my second Texas correspondent who maintains that it is impractical to consider live jazz in every hamlet throughout the United States. I was not emphasizing the divinity of New York, Chicago, and San Francisco as the the only centers where the saintly people live and congregate. I was simply trying to track the problem to its source. If we refer to the situation of the potential jazz lover in El Paso, we track the problem, as follows:

1. Our El Paso citizen is dependent on radio or records for his jazz participation.

2. It is possible for our El Paso citizen to enjoy, to a great extent, all the benefits of jazz participation if the following requirements are fulfilled:

a. Playback equipment must be the best possible . . . carefully correlated with the acoustical qualities of the room in which it is being used.

b. Records must be the best possible. . . . Hi-Fi, if you will, and completely representing the ordinary musical conditions of a jazz session; this involves recording under live conditions and with an eye towards indeterminate length (LP, in other words).

c. Quality jazz to record. This last point is the specific place on which my argument hinges. If all the other requirements are fulfilled, we still are faced with a situation in which not only our El Paso citizen, but all others are thoroughly cut off from the jazz experience. Unless live jazz exists, the jazz product will continue to be mediocre. My previous columns amplify this point *ad nauseum*, and I needn't repeat it here. If the source is taken care of, the rest follows in the manner indicated.

Letter No. 3 doesn't come from Texas, but is worthy of some concern. Our 3rd letter writer is convinced that Yma Sumac is a phony, primarily because her name makes sense when spelled backwards . . . it comes out Amy Camus. Since Amy Camus is a more rational name for a human being, Yma Sumac is a phony . . . or so our reader reasons. This may be true . . . I don't know. What information I have leads me to believe that she is on the level. I recently heard and saw her on television and she is still being massacred by poor audio and poor orchestrations. In addition, Slim Gaillard (of Slim and Slam fame) has recently released a take-off based, ostensibly, on Yma Sumac's vocal antics. The steel of the satire can massacre the princess unless somebody takes her in hand

and makes worthwhile recordings and orchestrations. The vocal gymnastics accomplish only one thing . . . her classification as a freak or a mere novelty. About time that somebody put a stop to it. In any case, it's a toss-up . . . Amy Camus or Yma Sumac.

#### The Basic Pop Catalogue

At long last, we begin the herculean effort. The first basic group is particularly interesting from many points of view. Glenn Miller has become an American myth, thereby making it commercially feasible for various contemporary organizations to imitate the inimitable Miller style. The innovation of the clarinet-saxophone choir set off a whole epoch in modern American pops. Miller's success must be seen against the background of the the period in which the organization came to the fore. Records were bought primarily for dancing purposes by high school and college kids who did most of their dancing in gymnasiums and auditoriums (or mom and dad's living room) to the blare of p.a. systems and cheap record players. Cheek-to-cheek dancing (involving a sentimental and distinctly lush background) required an orchestration and a beat that no other band could produce as successfully as Miller. Despite their inadequacy in terms of any absolute audio standard, the Miller recordings were technical gems in terms of the requirements they were set up to fulfill. The blend of sax and clarinet was so successfully accomplished that a quick comparison with the same efforts as recorded today by Tex Beneke and Ralph Flannagan's organizations points to the genius of the responsible Victor engineers of the late 1930's. The beat was perfect for smooth, slow, dancing and the blend was amazingly right for p.a. use. Without the competent engineering characteristic of Victor on the Miller discs, it is a moot question as to whether Miller would have been as big as he was.

Instead of listing the discs on domestic Victor, I am going to list a few HMV pressings of outstanding Miller recordings. The HMV's are tremendously superior, both from the point of view of surfaces and clarity. They sell for $1.05 (if you're asked for more, you're being rooked). If your local dealer does not stock them, they can be ordered from Victor. They are all available in good quantity in this country and are worth having. I know of no dance discs which fill the bill so satisfactorily for the type of dancing they were made for. These belong in a basic pops collection.

| | |
|---|---|
| **HMV MH-104** | Blue Orchids and A Cabana in Havana |
| **BD-5839** | Glen Island Special and Pagan Love Song |
| **BD-5834** | Moonlight Cocktail and Slumber Song |
| **BD-5850** | A Nightingale Sang in Berkeley Square and My Prayer |
| **BD-5833** | Rhapsody in Blue and Caribbean Clipper |
| **BD-5569** | Careless and Indian Summer |
| **BD-5784** | Let's Have Another Cup O' Coffee and Chip off The Old Block |
| **BD-5822** | Blue Moonlight and Melancholy Lullaby |
| **BD-5654** | Alice Blue Gown and Wonderful One |
| **BD-5854** | Sold American and Moon Love |

## RECENT RELEASES:

**Journey Into Melody** **London LPB-213**

Robert Farnon and Orch.

This is a particularly impressive ten-inch disc, deserving of praise from many angles. The recording job is amazingly good and totally devoid of the trickery characteristic of much of our domestic stuff. The general style is a hybrid mixture of Kostelanetz and Morton Gould, but decidedly lacking the vulgarities, over-orchestration, over-echo, and tricky mike-effects so often characteristic of the two. Nevertheless, the sound is luxuriant and smooth, with percussion admirably handled. This is a perfect demonstration of what can be done in the line of salon music without going overboard in orchestration tricks. The orchestra plays without woodenness and deals competently with a wide variety of styles. The arrangement of "Just One of Those Things" is the most tasteful in a long while and, because of a steady tempo, quite danceable. "Peanut Polka" is marvelously arranged and recorded and the best waltz recording for dancing and smooching purposes in a king's age is the "Invitation Waltz" which purrs like a contented kitten. Other neat bands include a decent job on "April in Paris," an expert job on "In a Calm" and a rousing job on "Popcorn Polka." One of the outstanding merits of the disc lies in the fact that one is not over-conscious of the expertness of the recording job, allowing a relaxed listen without the typical "anxiety neurosis" of the audio hound.

**The New Sound** **Capitol H 226**

Les Paul

Wow! What a recording! This one takes your breath away. From comments made out of the side of my typewriter for months, you may have gathered that I am not a particular admirer of Les Paul. He is a cutey, in the vernacular of the trade, and his pre-eminence as a jazz guitarist is totally undeserved. But this recording . . . . The blurp on the sleeve coyly points out that Paul is playing eight guitars (simultaneously) and that how it was done is Paul's secret. We needn't bother ourselves too much probing for the secret because the method is obvious. What is important is that purely in terms of the instrument and the stuff recorded, this is one of the great engineering achievements of this age. The clarity of the recording is unbelievable. The usual overtone resonance in guitar recording is missing and the percussive nature of the pluck comes through clear as a bell. The dubbing of the eight guitar voices is magnificent, with a perfectly balanced blend throughout. Included are things like Brazil, Caravan, What Is This Thing Called Love, Lover, Hip-Billy Boogie, Swiss Woodpecker, and The Man on the Flying Trapeze. The arrangements are cute, amusing, and listenable. To Capitol, the "Top o' The Morning," the Croix de Guerre, the ribbon of the Legion of Honor and congratulations on one of the most splendiferous recordings these ears have ever heard.

**RCA Victor** **Small Combo Hits**

Popular Collector's Issue Series

Along with Victor's release of rare vocal items in its classical catalogue has come a selection of popular stuff which deserves

close attention. These are dubs of items in the Victor pop catalogue and are splendidly done. Available on both 45 and 33 1/3, my preference is for the 45 job because selection is of the greatest importance. Most of the recordings in this particular set were made between 1936 and 1940 and even in their dubbed state reveal the immense degree of striking accomplishment already achieved in the pre Hi-Fi period. Included are the Benny Goodman Quartet (including Teddy Wilson, Gene Krupa and Lionel Hampton); the famous 1937 Jam Session at Victor (with Bunny Berigan, Fats Waller, Tommy Dorsey, Dick McConough and George Wettling being righteous); the Bunny Berigan Crew in the 1938 recording of Bix's "In a Mist;" the massive and great "Body and Soul" of the "Hawk" (Coleman Hawkins); the Artie Shaw Grammercy Five job on "Smoke Gets in Your Eyes;" and Lionel Hampton, augmented by the King Cole trio and drummer Al Spieldock doing the fabulous "House of Morgan." If you're interested in the stuff, buy it on 45; be assured that the dubs are good and, with moderate reservations, all the dates are distinguished by good music and good playing. What is more important is the impressive way that this stuff was recorded. In a five year span, the consistent quality of the recordings, in every respect deserves further comment. Instrumental sound is pure and clean. Balance is perfect, with percussion magnificently handled. Surfaces were invariably good, despite occasional rough spots.

## SOUND SYSTEMS

[*from page 25*]

Although designed primarily for industrial use, all elements of the 1400 series amplifiers will more than meet broadcast standards as to frequency, distortion, and noise level. This was considered necessary because in the Survival Sound System we are dealing with "life or death" matters and nothing less than perfect articulation can be tolerated. It is bad enough when the quarter back's signals are misunderstood and the ball is passed one direction while the receiver mistakenly runs the other direction. The entire reason for the Survival Sound System is to prevent this from happening during an emergency.

The theme of high articulation is continued by a close-talking dynamic microphone for speech frequencies only, coded 632C. Its frequency response is designed to give a slightly rising characteristic up to 8,000 cps for maximum emphasis of the important intelligibility range of the voice spectrum. In physical appearance it looks like a shortened version of the well-known 633A "salt shaker" and has the same sturdy characteristics. The 632A is for speech only and, of course, more suitable microphones should be selected for music pick-up.

**Loud Speakers**

The loudspeakers are the last important element of the Survival System. Many suitable varieties of speakers are available, but again uncompromising emphasis must be placed on low distortion and high intelligibility of speech

through noise and other adverse conditions. Ten to twenty per cent of the personnel will suffer from serious hearing defects in various degrees, yet their lives are just as important as others. To accomodate these will require a speaker with plenty of smooth high frequencies that are not muffled by the all-too-common broad loudness peak which is present in the midrange of many low price speakers, and speakers generously located throughout every area where persons work or congregate.

Generally, the "low-level" system of many speakers at frequent locations is preferable for the usual plant or commercial establishment, and overhead ceiling mounting is generally preferable because variations in sound level due to the square-of-the-distance law are held to a minimum. Methods of ceiling mounting and appearance are usually no problem in factories but it is a matter of concern in stores and similar commercial buildings. One way of solving this in an attractive manner is shown in the illustration of how some eight hundred 755A speakers were installed in Hess Brothers Department Store in Allentown, Pa. This shallow 8-in. speaker requires only a two-cubic-foot baffle for optimum operation and has an unusually smooth high-frequency response up to 13,000 cps.

In a number of cases a source of emergency power supply is specified as a vital auxiliary to the Survival Sound System. The auxiliary source should be set up to throw over automatically on any interruption of the standard supply.

The Survival Sound System is definitely the need of the present and of the continuing future. Talk to a department store manager about an ordinary sound system and chances are you will get a glassy stare, but broach the subject of a Disaster or Survival Sound System and the department store man becomes all attention. Civilian Defense and personnel protection measures are matters of grave concern to most business heads.

This concern is not limited to Eastern or Western sea coasts, but extends to all industrialized areas. The National Civilian Defense Administration has designated approximately 200 locations as "Strategic Target Areas", half of which are further qualified as "critical" and almost 20 per cent as "super-critical". Although a list of these areas is not available for the asking, it is understood that information as to whether a particular location is rated as a strategic target for enemy attack can be obtained by residents of that location if they write to the State Civilian Defense office.

The idea of the Industrial Sound System cannot be classed as a fad which may pass with the apparent quieting of the world situation. Our top military leaders have given congressional testimony that the country must remain in a state of preparedness for a term of at least 10 or 20 years. With memories of Pearl Harbor still fresh, with jet ocean

crossings are made speedier and speedier and remotely guided missiles becoming more practical, our nation and our industries must be constantly prepared to cope as best they can with the devastating sneak attack. The Survival Sound System idea will quite likely become a standard consideration for architects in all future industrial construction.

Although the subject of this article is a specialized sound system application apropos the times, one must not overlook that investments in a Survival Sound System as such is by no means a loss should no enemy attack occur. Such a system, amortized as a protection measure, can only pay off with all the proven advantages of the ordinary plant sound system — time saving paging, music distribution for morale and increased production, and other proven benefits.

## TECHNICANA

[*from page 6*]

were made over two transmitters on different frequencies.

The r.f. coil block units are essentially a French specialty. They are units of coils completely assembled and frequently designed for multiband use. The availability of several broadcasting bands to the French listener has probably been responsible for this design trend, but nonetheless these units appear to be rugged in construction and stable in operation, lending themselves well to designs in which stability and uniformity in mass production of high-fidelity equipment are of importance.

#### Transmission Measuring Set

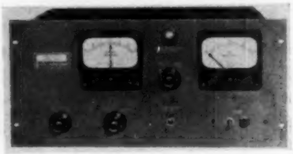
J. M. Hudack is the author of an article in the December 1950 *Bell Laboratories Record* describing a new automatic transmission measuring set. This new instrument measures and records on a paper chart the transmission characteristic networks and amplifiers in the ranges 20 to 20,000 cps and 100 to 100,000 cps in a much shorter time than the old point by point method.

In this measuring set the input signal is generated in a beat-frequency oscillator in which the high frequencies are 650 kc and $650 - f$ kc. This signal of $f$ kc is fed to the device under test and then into a receiving amplifier. The received signal is again heterodyned with the $650 - f$ kc signal from the first b.f.o. The output of the heterodyne circuit now contains a 650-kc signal—the amplitude of which is a function of the output of the unit under test—and a number of distortion products. This 650-kc output is fed to another heterodyne modulator, where it beats with a 553-kc signal from a local oscillator. Its output contains a 97-kc fundamental signal and the modulation products. The 97-kc signal amplitude is a function of the transmission characteristic of the unit under test. This signal is fed through a 97-kc crystal filter with a 20-cps pass band to a level recorder. The range of the instrument is 50 db. It occupies two rack frames mounted on a single castered base.

The transmission set may also be used to analyze amplifiers and networks for harmonic distortion and noise. Also with two extra oscillators measurements of intermodulation distortion products are readily accomplished.

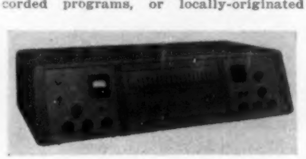
# NEW PRODUCTS

• **FM Communications Monitor.** Designed for use by non-technical personnel, the new Model 337A-B FM communications monitor, manufactured by Hewlitt-Pack-



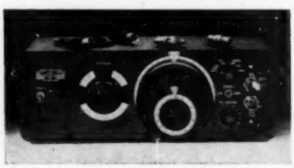
ard Company, 395 Page Mill Road, Palo Alto, Calif., is a unit equalling in performance similar equipment considerably higher in price. Using the same pulse-counter circuits employed in the company's monitors for commercial broadcasters, Model 337A-B does not require tuning of discriminators or frequent adjustment of voltage levels. The unit gives continuous indication of frequency and modulation swing, and includes a peak modulation indicator and an audio output for aural monitoring. Frequency range is 30 to 175 mc.

• **Dual-Channel Audio Control Consolette.** A high degree of flexibility suits the new RCA Type MI-12781 dual-channel consolette for an endless variety of applications in the field of industrial sound. Designed to provide a choice of radio programs, recorded programs, or locally-originated



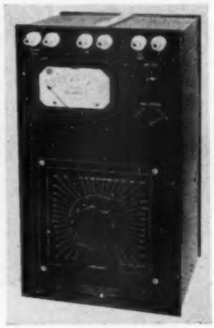
live program material to as many as 40 selected areas, the unit incorporates two complete audio channels which, when desired, may be connected together to furnish the same program to all areas. In addition to control facilities, the consolette incorporates two 30-watt high-quality amplifiers, matching transformers and monitoring speaker. Further information available from RCA Victor Division, Radio Corporation of America, Camden, N. J.

• **Wide-Frequency-Range Bridge Oscillator.** Intended for use in antenna and bridge measurements, the new General Radio Type 1330-A bridge oscillator is an excellent generator for all bridges oper-



ating in its frequency range. A continuously-variable r.f. range from 5 kc to 50 mc is provided, also three audio frequencies including power-line, 400, and 1000 cps. Output voltage is approximately 10 volts, and more than one watt can be delivered into a 50-ohm load over most of the frequency range. The 1330-A is considerably lighter and smaller than its prewar counterpart, yet covers a wider frequency range and supplies about ten times the output power at a lower impedance level.

• **Output Power Meter.** Covering the range from 0.1 mw to 100 watts, the new Daven Type OP-962 output power meter is designed for use at forty selected impedances ranging from 2.5 to 20,000 ohms. Provision is made for use of a calibrated external amplifier to extend the range below 0.1 mw, also for connecting an oscilloscope to observe wave shapes. Featuring a large meter for ease in observa-



tion, Type OP-962 is enclosed in a ventilated metal housing 15¼ × 8⅝ × 8⅜ in. and weighs 20½ lbs. Full technical description will be supplied on request by The Daven Company, 191 Central Ave., Newark 4, N. J.

• **Public-Address Horn.** Designed with a low-frequency cutoff at 250 cps, the new Racon Model COB-11 "cobra" type horn provides a uniform sound field over a horizontal angle of 120 deg. and over a vertical angle of 40 deg. Exponentially flared for maximum efficiency, the COB-11 is especially effective where p.a. requirements call for clarity of sound with maximum concentration of energy in a horizontal plane. The horn may also be used as a middle-register or high-frequency tweeter in multi-speaker wide-range audio

systems. Thread size of throat is 1⅜"–18, permitting the use of any standard 25–35 watt driver. Further details of this model, as well as complete information on the remainder of the Racon line, may be secured by writing direct to Racon Electric Co., Inc., 52 E. 19th St., New York 3, N. Y.

• **Five-Range Treble Filter.** Designed for attenuating disturbances in the high frequency audio range, the Type OA-1 ad-

justable filter may be used for minimizing record surface noise, 10-kc heterodyne whistle etc. The filter connects between the outputs of typical tuners or phono pre-amplifiers and usual input circuits. Full description may be obtained by writing the manufacturer, Berkeley Custom Electronics, 2216½ Grant St., Berkeley 3, Calif.

• **Miniaturized Staple Tacker.** Small in size, yet equal in performance to a large industrial counterpart, this new tool will effect savings of both time and money in all sorts of wired sound installations. Using an improved staple available in a variety of colors, the tacker may be used for fastening wire to plaster, composition board, hard and soft wood, with holding power up to 64 lbs. Staples are driven to desired depth without injuring insulation.

Both the tacker and staples are designed to A. T. and T. specifications and, according to the manufacturer, are now used for installation of low-voltage telephone wiring throughout the Bell System. Manufactured by The Heller Company, 2153-N Superior Ave., Cleveland 14, Ohio.

• **Univerter.** The new Type 207-A univerter, manufactured by Boonton Radio Corporation, Boonton, N. J., is an accessory instrument designed to increase the usefulness of the Boonton Type 202-B FM signal generator. While the 202-B normally covers a frequency range of 54 to 216 mc, in combination the 202-B and the 207-A provide continuous frequency coverage from 0.1 mc to 216 mc. Type 207-A univerter is a frequency converter having unity gain. It is provided with frequency increment dial calibrated in in-

crements of five kc from plus 300 kc through zero to minus 300 kc. This feature permits making selectivity measurements on narrow-band receivers. Complete details may be obtained from the manufacturer.

• **Chairside Cabinet.** Manufacturers of radio-phono combinations will find interest in this unique cabinet recently placed in production by Standard Wood Products Corp., 43–02 38th St., Long Island City 4, N. Y. Although large enough to accomo-

date both a radio and standard-size record changer, the cabinet is made of Formica, and is available in a choice of blonde or mahogany finish. Overall dimensions are 20" high, 16" wide, and 18" deep. Features authentic Modern styling. Further details may be obtained by writing direct to the manufacturer.

• **Tape Transport Mechanism.** Designed solely for playback purposes, the new Presto Type TL-10 magnetic-type drive can be quickly installed on any standard 16-in. turntable, thus providing the user with a high-quality tape reproducing unit at low cost. Driving power is obtained from the turntable and equalized output level is high enough to be fed directly into standard speech input equipment. Performance specifications are governed by the equipment with which the TL-10 is used. Speed regulation is equal to that

of the turntable alone, while signal-to-noise ratio is dependent primarily on the amplifier. Frequency response of the TL-10 head is uniform from 50 to 15,000 cps at a tape speed of 15 in. per second. Descriptive bulletin may be obtained by writing Presto Recording Corporation, P. O. Box 500, Hackensack, N. J.

• **Crystal Microphone.** Low cost and good audio quality are both featured in the new Turner Model 60X microphone. Equally well suited for hand, desk, or stand use, the 60X has a frequency range of 70 to 7000 cps and features a moisture-


sealed crystal making it ideal for use under varying conditions of humidity. Attractive case is finished beige wrinkle enamel. Supplied complete with 6-ft. cable and stand adapter. For complete details write The Turner Company, 900 17th St., N.E., Cedar Rapids, Iowa.

## RECORD REVUE

[*from page 30*]

seeming lack of appreciation of some very fine recorded sound. But certain anachronisms were quickly evident.

Remember, for instance, when we used to enjoy tossing plastic records around to show how they wouldn't break? That fad is now more or less over hereabouts, merely because untold millions of plastic records have taken the novelty away. But I remember well enough—it was only three years ago, though it seems ten—doing the same, with great glee. I remember proudly carting around my first genuine LP's to show off, to the utter amazement of friends and relatives. Same with 45's a bit later. I remember ('way back then), tossing 45s' like doughnuts, dropping LP's from a height of six feet while all eyes were averted in involuntary terror. . . . All of which was mildly re-experienced during the course of our social evening with EMI's new test pressings. Another era!

And the sound? There we come to the real point. Which is simple enough, and represents a very important line of thought, I'd say, for any of us today. The question in my mind was—am I supposed to be *listening to LP's—to 45's?* Or am I listening to *recordings*, which happen to be pressed in one of the standard alternative forms now available?

#### Focus on LP

Perhaps my point isn't entirely clear, even after "all" these years. When LP began, over here, the great argument back and forth and through and through the industry was "how good are LP's?" How bad? Eveything was tied to the LP itself. The ancient controversy upon "fuzziness" in LP's, which eventually proved pretty conclusively to be a matter of improper cartridge performance, was a fine case in point. The focus of all our attention was on the LP as a system. We listened to LP's and we judged them *as LP's*—not as recordings.

We judged the Whole instead of its Parts. We lumped all sorts of attributes under one heading—LP. Attributes that often were totally unrelated one to the other. LP's had "thin bass" (or thick); they had screechy treble (or no treble), they had wows, they buzzed, and so on. All of which were distinct and separate factors, elements in the total LP process, yes—but not *typical* of LP, as such. When 45 came along, we indulged in a new frenzy of comparisons that have since proved to be pretty pointless. Which had the most distortion or the least? It all depends! Theory as to optimum diameter vs. speed, etc. etc. is relatively unimportant, we now can see, in comparison with the enormously greater practical variations in many aspects of recording—some of which constitute values or problems common to both LP and 45, a few—a very few—being exclusive to one or the other.

And so, my impression in listening to the EMI test pressings was, again, one of a difference in viewpoint. I was being shown precious advance tests of a new system; they were, to me, physically like a hundred tests I've looked at and heard—that is, they were simply so many records. What was on the records was what counted.

And it happened that a good number of Mr. Barrell's LP tests were taken from disc, rather than from the tape that EMI, like everyone else, is using more or less exclusively for new recording. Nothing exceptional about that—EMI has some very fine discs hanging around and they no doubt made handy material for testing purposes. (Though, even so, I think that we here would tend automatically to use tape originals for testing a new system of any sort, these days. Disc is out of date, even at best, from the technical point of view.) Since the EMI tests were, then, from disc, I couldn't help listening to them as convenient reproductions of those fine disc recordings—to me they were a sort of transparent medium, a convenient method of hearing the original. (They were perfectly good microgrooves—why shouldn't they be, after all? I would have been astonished if they had *not* been good ones.) I listened as one listens to a good tape recording of a broadcast —not to the tape but to the broadcast itself.

#### Disc-ness of Sound

I became absorbed, as a matter of fact,

in an irrelevancy (from EMI's viewpoint), the "disc-ness" of the sound; one test was so good that I could have sworn it came from no disc, on first hearing, though on repeat there were some loud passages that might betray a disc origin for one looking very hard for evidence. Others, though excellent wide-range recording, had that unmistakable slight metallic resonance (if that's the word) which says "disc." Yes, I was thinking, the removal of the mechanical moving element in favor of all-electronic recording brings a sound to the best tape that is undeniably a step beyond the very finest disc—at least in the more heavily modulated sections. Only common sense to expect this . . . and, you see, in no time at all I was a thousand miles away from any consideration of LP or no LP. Forgot I was listening to LP.

**Miraculous Intuition**

I repeat—no offense to EMI and EMI's excellent tests. As a matter of fact, we've been hearing more extensive tests of the same, via the EMI-cut British Columbia LP's which have been pressed directly on the Columbia label over here right along with our own recordings. For all my irrelevant ruminations, I did get an excellent impression, too, of the EMI plastic material—very quiet and up to the best—which I gather is entirely made in Britain, via coal products from Wales. I was left without any clear idea of EMI's recording curve in the tests, because our adjustments were mostly aural and I don't have Editor McProud's (unmarked) controls memorized yet.

But may I remark in utmost seriousness, to Mr. Barrell and EMI, that top-quality microgroove recording these days over here, is no monopoly of the big-company label. The EMI tests were excellent. But I've heard dozens of just-as-good tests from tiny outfits whose total capitalization is perhaps one millionth that of EMI. Granted that it's the big outfits who make this possible—the tape manufacturers, the processing and pressing facilities that can be still bought or rented so cheaply today in spite of rising prices for everything. A good LP or 45 recording, speaking purely from an engineering viewpoint, is a commonplace almost. Or, to put it another way, standards of excellence have risen all along the line. A good *original recording*, however, is still a matter for miraculous intuition! The British have always been tops at that side of things—and so you can't blame me for listening, not to EMI's microgrooves, but simply to EMI's recording. Nice, too.

## NEW RECORDS

**Milhaud, Serenade for Orchestra (1921); Five Studies for Piano and Orch. (1920); Maximilian Suite (1932), Three Rag Caprices (1927).**
Vienna Symphony, Swoboda.

**Westminster LP**
**WL 5051**

"Polytonality," they called it in the 1920's and people shuddered with horror. Polytonality it is still, today, at least in a reasonable way, but strangely enough, it doesn't really hurt any more. This is a nicely representative collection of the snazzy youthful Milhaud, *enfant terrible* of French music, in the days before he became a relatively respectable middle-aged composer as now; but you'll hear in this music, perhaps to your surprise, a lot of familiar sound ranging from Gershwin to Leonard Bernstein ("On the Town") and Morton Gould; not to mention about half the film music ever written. It's dissonant music—as dissonant as ever any composed—but the system is simple and the tunes are catchy and even popular, the whole with a slightly delicious atmosphere of *scandale, à la Folies Bergères*. Can't help likin' this man.

Recording? Lovely, with fine brass edge, good acoustics. Comes pretty close to being one of those hi-fi demonstration discs. Remember *Ionisation?* He was French too.

**Songs of the Auvergne**, arr. Canteloube. Folk Songs. Susan Reed; instrumental ensemble.

**Columbia LP:**
**ML 54368**

Some engineer-music-lovers will remember the famous Madeleine Grey recording of these, reissued a few years ago (on 78) by Columbia after much campaigning on the part of record buyers. The songs are fascinating, and are set to a sort of symphonic-poem accompaniment by Canteloube, the whole being

quite unique in music. Susan Reed does a surprisingly nice job with them, though not as note-perfect as the highly trained Grey; her "orchestra" is a small group, about 4, but in quite respectable condensations of the original score. And the whole is, of course, hi-fi, so those who couldn't ethically accept the old low-fi records (some people just *won't* play a low-fi record) can take these without a qualm of hi-fi conscience! Susan's own renderings of U.S. folk songs, on the reverse, are a bit corny to my ear. She was a night club success with them, though—so suit yourself.

**Music With Harp. (Ravel, Debussy, Saint-Saëns, Fauré)** Edw. Vito, Stradivarius Quartet, etc.

**Stradivari LP SLP 1007**

This small company has been doing excellent work in the French music area with a group of younger American musicians. This one gives you a fine glimpse at the masterful way in which the French use the exotic sound of the harp to top advantage. The recording is excellent, though not showy. Since first going over these I've made one discovery-with-time that dampens my enthusiasm. The record material wears out in a very short time, if you give it hard treatment, as I do in rehearsals for broadcasts, etc. Probably a lot of fill in it—the sound is quite OK; it's merely a matter of wearing quality. This is cited as one example in an aspect of the business we must keep an eye on, for our own best interest. Other companies do the same, too, you may be sure. I noted a decided contrast in wearing qualities when I happened to work, at about the same time, with an RCA and a London record, neither of which showed unpleasant wear even after dozens of playings of the same spot.

**Schubert, Unfinished Symphony.**
a) NBC Symphony, Toscanini.
**RCA Victor LP LM 54 (10")**
b) Bamberg Symphony, Heger.
**Mercury LP MG 10034**

**Schumann, Kinderscenen. Chopin, Mazurkas.**
Horowitz, piano.
**RCA Victor LP LM 1109**

**Chopin, Sonata in B Flat minor. Barber, Sonata (1950).**
Horowitz, piano.
**RCA Victor LP LM 1113**

**Mendelssohn, Trio in D. Ravel, Trio in A minor.**
Rubinstein, Heifetz, Piatigorsky.
**RCA Victor LP LM 1119**

**Tchaikowsky, Trio in A Minor.**
Rubinstein, Heifetz, Piatigorsky.
**RCA Victor LP LM 1120**

The above recent RCA Victors represent a cross section of the RCA stable, lumped herewith merely because these all happen to be new representatives of the noticeably absent bass. Might be high turnover point and no more—but a lot of boost in the bass still doesn't seem to add anything really solid, on a big machine (though boosting reveals a nice absence of extraneous rumble, hum, thump, etc.). These'll all sound fine on most home machines that don't reproduce bass anyway and that's where most of 'em will go—so we can't complain. Just for the record.

The Schubert Unfinished (bass aside) is another typical Toscanini, most likely of a vintage with those issued last spring, and contrasts interestingly with the utterly different Bavarian version on Mercury. Toscanini's recording is dead, sharp, clear; his performance is accurate, intense, streamlined, tight, quite fast. The Bavarian job is big, slow, heavy, lyric, leisurely, schmaltzy, not always accurate in detail. If we could only get some mythical conductor who would combine the virtues of both—for the Bavarian style is probably nearer the real sense of the music—which is essentially South German music, remember, and not Italian. Lotta difference. Mercury's recording has big spaciousness, lots of highs and plenty of bass; also some most unpleasant taped hum or motor noise. (Its other side has the "Rosa-

munde" music, with a 6000-cps apparent cut-off.)

Horowitz' LP piano has an absolutely astonishing lack of bass. No better description for it. His playing is brilliant, a bit too cold and objective for the highly personal Schumann and Chopin items. There is some tape flutter, here and there. The new "Million Dollar Trio," with Piatigorsky replacing the earlier Feuermann cello, is a stunning ensemble, but for my taste in the listening a bit too eclectic—i.e., they play almost everything alike, and one hears Heifetz, Rubinstein and Piatigorsky, each doing his own typically personal style. Nevertheless, few ensembles can match theirs in over-all projective power and brilliance. Again, no bass.

**American Songs (18th century).**
Margaret Truman, Robert Shaw Chorale, RCA Victor Orchestra.

**RCA Victor LP**
**LM 57 (10")**

**Helen Traubel Sings Wagner (vol. 2).**
With RCA Victor Orch., Weissmann.

**RCA Victor LP**
**LM 1123**

Just for the record—these two, for reasons not entirely clear, seem to have all the bass one needs, given a bit of tone adjustment. A certain percentage of RCA's continue to appear thusly. La Truman does a nice small job with some very simple and charming drawing room songs; the Chorale also does well (and is beautifully recorded) with the rougher, untutored sort of early American music. Traubel is a lot better here than those who may not fancy her singing are likely to expect. I've heard better Wagner, but not by a very large margin, all things considering. The characteristic Traubel heaviness of touch is minimized, the voice is at its best, the musicianship unexpectedly good. And a superb recording job, too. Flagstad fans had better try this, just to keep up with current events in the field.

**Beethoven, Violin Concerto.**
Francescatti; Phila. Orch. Ormandy

**Columbia LP**
**ML 54371**

**Mendelssohn, Violin Concerto.**
Stern; Phila. Orch. Ormandy.

**Columbia LP**
**ML 4363**

**Beethoven, Piano Concerto #5 ("Emperor")**
Serkin; Phila. Orch., Ormandy

**Columbia LP**
**ML 54373**

Here you have a trilogy of concertos with to my mind the most satisfactory answer to the problems of recording the solo-orchestra combination to date. Not only a wonderful, big, deep, live orchestra, but an "enveloping," surrounding effect that blends solo and orchestra without blurring the contrasts between them. Not a concert hall effect at all, as a matter of fact—but an ideal *recorded sound* effect, the best one can do with the monaural situation, which is utterly unlike the binaural situation in an actual concert hall, as we all should know by now. Only the individual quality of solo instruments could here be questioned. Stern's violin playing is recorded with a huge sound, a bit blurred by the liveness; Francescatti's is the better effect, I'd say, with a sharper, cleaner sound, less exaggeratedly large. (But this is almost splitting hairs—both are excellent). Serkin's piano is strangely distant, and lacks bass in the recording, though the orchestral bass is fine. Not a bad effect at all; just unexpected. As for the orchestra—Ormandy's playing is conditioned, it seems, by the qualities of his soloists. The Mendelssohn is more masculine and solid here than the Beethoven—because of Stern's playing in it; Beethoven is beautifully slick and smooth with Francescatti. Quite French, indeed. With Serkin at the pianistic helm, Beethoven's Emperor is as electric as Serkin himself, which is definite high voltage. Ormandy's an excellent accompanist, no doubt about it.

## CIRCUITS SURVEY

[*from page 15*]

loading of the other, with both grids driven; (8) plate loading of one tube and cathode loading of the other, with one grid and the free cathode driven; and (9) loading both plates and both cathodes, with the grids driven in push-pull.

The first six can be rejected with the aid of the above considerations, leaving but three circuits for analysis.

The seventh can be connected as shown in *Fig.* 2(a), with the tubes connected in series across a split power supply. If the circuit is balanced, direct current does not flow through the output-transformer primary. Push-pull operation is obtained, since the plate current of one tube increases as the plate current on the other tube decreases. To satisfy the third requirement it will be noted that the alternating components of the plate currents of both tubes flow through the single output-transformer primary.

Disadvantages of the scheme are that twice the normal power-supply voltage is required, and that a large driving voltage is required by the upper tube.

It is of interest to note that the output impedance is very low—essentially that of the upper tube operating as a cathode follower—while the plate load is computed as for parallel operation. If a split-primary output transformer is available, the two halves of the primary can be connected in parallel, with improved high-frequency response.

The method of obtaining grid drive shown is one possibility; it may not be the best.

The need for a double-voltage power supply can be eliminated by rearranging the circuit as shown in *Fig.* 2(b), and employing a transformer with two primaries, $P_1$ and $P_2$. The other advantages are retained, as is the disadvantage of large driving voltage for one tube. The coupling capacitor between plate and cathode will improve high-frequency response if the coupling between the two halves of the output-transformer primary is not perfect.

The eighth circuit appears to be of no particular advantage, as grounded-grid operation of one tube will require additional driving power. The remaining grid, which is associated with a cathode follower, will still require a large voltage. However, an interesting combination of (7) and (8) exists,[3] as shown in *Fig.* 2(c).

It will be noted that $V_1$ is driven in the normal manner, while the drive for $V_2$ results from the voltage across $R_k$. Since this voltage will increase as the load impedance is decreased, one would expect the circuit to have a low output impedance. A practical advantage is that push-pull driving voltage is not required.

### Gain and Impedance

It is of interest to derive the equations for the open-circuit voltage gain and the output impedance of the circuit. To obtain the voltage gain, the amplifier is split, as shown in *Fig.* 3(a). The equivalent circuits are shown in (b) and (c). Here $V_2$ is considered as a cathode follower with a resistance $R_k$ connected between its grid and cathode, while $V_1$ functions as a grounded-cathode amplifier, with a load consisting entirely of $V_2$. Assuming the tubes to be identical, and considering *Fig.* 3(b),

$$\frac{e_3}{e_2} = \frac{R_p + \mu R_k}{R_p + (1+\mu) R_k}; \qquad (1)$$

considering *Fig.* 3(c),

$$\frac{e_2}{e_1} = -\frac{\mu\,[R_p + (1+\mu)\,R_k]}{2\,R_p + (1+\mu)\,R_k}. \qquad (2)$$

Forming the product of *(1)* and *(2)*, it is found that the overall voltage gain

$$\frac{e_3}{e_1} = -\frac{\mu\,R_p + \mu^2\,R_k}{2\,R_p + (1+\mu)\,R_k}. \qquad (3)$$

If $\mu \gg 1$,

$$\frac{e_3}{e_1} \approx -\frac{R_p + \mu\,R_k}{\dfrac{2\,R_p}{\mu} + R_k} \qquad (4)$$

*Figure* 3(d) shows that the output impedance $Z$ of the amplifier consists of $R_p + R_k$ in parallel with the output impedance of $V_2$, which must be evaluated

[3] Maurice Artzt, "Survey of direct-current amplifiers," *Electronics*, p. 112, Aug. 1945.

separately. *Figure* 3(e) is the equivalent circuit for $V_2$ alone. Applying a voltage $e$ as shown,

$$\frac{e}{i} = \frac{R_p}{1 + \frac{\mu R_k}{R_p + R_k}} = Z_2 \qquad (5)$$

Where $Z_2$ is the impedance of $V_2$ alone. Paralleling $Z_2$ with $R_p + R_k$ to obtain the output impedance of the amplifier,

$$Z = \frac{R_p (R_p + R_k)}{2 R_p + (1 + \mu) R_k} \qquad (6)$$

**Example**

To study a practical example, one might consider the use of two 6L6 tubes with a 500-volt plate supply. If $R_k = 170$ ohms, $R_p = 22{,}000$ ohms, and $\mu = 135$. Substituting in *(4)* and *(6)*, $e_2/e_1 \approx -90$, and $Z = 7300$ ohms. Inspection of a tube handbook[3] shows the optimum load impedance to be 1250 ohms, with an output of approximately 14 watts. The required r.m.s. grid drive is 10 volts, while the r.m.s. signal current per tube is approximately 50 ma. Since this current flows through $R_k$, it is necessary to increase $R_k$ to 500 ohms to obtain

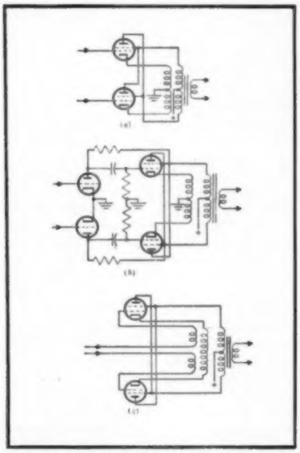


Fig. 4. Plate-and-cathode-loaded output stage circuits.

sufficient driving voltage for $V_2$. The more elaborate circuit of *Fig.* 3(f) was employed to obtain the proper bias for $V_2$ with the increased value of cathode resistor. Substituting the new value of $R_k$ in *(4)* and *(6)*, $e_2/e_1 \approx -110$, and $Z = 4{,}500$ ohms. The output impedance is lower than that normally obtained with a pentode amplifier, which permits a good damping factor to be obtained with a moderate amount of feedback.

The amplifier of *Fig.* 3(f) gave good results; however, it was found that clipping occurred at the comparatively low level of 15 watts. This resulted from the fact that the drive from $V_2$ comes from $V_1$; and therefore, when $V_1$ overloads, there is a rapid deterioration in the output of the amplifier.

A disadvantage of the circuit is that the value of $R_k$ for proper a.c. balance is a function of load impedance, with the possibility of even-harmonic distortion production when operating into a fluctuating load such as a loudspeaker.

**Plate- and Cathode-Loaded Circuit**

The last scheme to be considered employs plate and cathode loading of both tubes,[4] as shown in *Fig.* 4(a). By using a bifilar output-transformer primary, excellent coupling is obtained between the two tubes, permitting class-B operation with very low distortion. Signal currents add in the transformer windings, permitting the use of a low load impedance, while the d.c. flux is canceled. However, because of the cathode loading, degeneration occurs, and a large driving voltage is required.

A resistance-coupled driver was tried with this amplifier; results were disappointing until the driver plate supply was increased to 500 volts. This disadvantage was eliminated by use of the "bootstrap" driver shown in *Fig.* 4(b). Here each of the driver plate-load resistors is returned to the plate of the opposite output tube which, to an approximation, has the effect of doubling

[3] RCA Tube Handbook HB-3, vol. 3-4.

[4] Frank H. McIntosh and Gordon J. Gow, "Description and analysis of a new 50-watt amplifier," AUDIO ENGINEERING, p. 9, Dec. 1949.

the driver plate-supply voltage. An amplifier and special output transformer were constructed and excellent results were obtained provided that the output stage was operated without grid current. The effect of "bootstrapping" is to raise the equivalent driver impedance, which produces severe clipping when grid current flows.

A third modification of the plate-cathode output stage is shown in *Fig.* 4(c). It is seen to be similar to that of (a), with the addition of a grid winding for each tube. Driving voltage is applied between the grid and cathode windings, avoiding degeneration, while the other advantages of the original circuit are retained. This driver impedance can be made low if the transformer resistance and leakage reactance are small. Satisfactory results can be obtained by using a trifilar winding. Driving voltage is obtained conveniently from a push-pull cathode follower, which eliminates the need for an interstage transformer. The principal disadvantage of the circuit is that a special output transformer is required. An experimental amplifier using this scheme was constructed, and tests showed that a total harmonic distortion of less than 0.5 per cent was obtained over the frequency range from 20 to 20,000 cps when employing 6L6 tubes. The power output was maintained constant at 25 watts.

### Conclusions

After considering the several circuits discussed above, one is left with some doubt concerning the best application of each. Assuming that low distortion is essential, the circuit of *Fig.* 1(b) is satisfactory where the low-power output associated with class-A operation is sufficient. The special circuits of *Fig.* 2 are also subject to this limitation; however, they have the advantage of operating the tubes in parallel rather than in series, permitting a less critical output-transformer design. The circuit of *Fig.* 4(a) permits class-B operation with low distortion, and is to be recommended where the maximum power output is required. The circuit of *Fig.* 4(b) will give good results with class-AB operation, but is not suitable for a class-B output stage because of the high apparent driver impedance. The capabilities of *Fig.* 4(c) have not been fully explored; however, with a good output-transformer design it should be similar in performance to (a), with the advantage of requiring a smaller driving voltage.

## AUDIO PATENTS

[*from page 4*]

The conductor covers the entire stylus tip up to a height of .0005 inch. From there on upward, a nonconducting segment on each side of the body divides the conductor into two parts.

The upper end of the shank is rectangular and fits into a socket in the cartridge so that it can go in only two ways, 180 deg. of rotation apart. Then the two conducting segments are placed in series with the lead

going from one side of the coil or crystal element to the amplifier.

Normally the circuit is complete because of the small conducting area completely around the stylus tip. But as soon as that half-thousandth of an inch of tip is worn off the connection breaks and no more sound comes out of the speaker. The user either buys a new stylus or listens to the radio. In any case, he knows when the stylus is dangerous and his records stay in good condition.

## THE LORAN TRAINER

[*from page 14*]

miles per second and the velocity of radio signals about 160,500 nautical miles per second or about 870,000 times as great. Consequently, it is convenient to scale down the actual radio loran system to a system of ultrasonic nature in order that a great portion of the earth's surface can be represented on a operating table of practical size. Using the previously mentioned ratio of sound to radio waves in air, the geography of the desired area on the trainer operating table is constructed to a scale of 1 inch equals 11.93 nautical miles. In other words, the trainer operating table becomes a miniaturized version of a complete loran system. The actual size of the table used is 8 feet by 8 feet and the working area represents approximately 1,300,000 nautical square miles of the earth's surface. The radio transmission in the actual loran system is replaced in the miniature one by 175-kc ultrasonic waves with pulse modulation characteristics essentially similar to those used in actual loran. An ultrasonic frequency of 175-kc is used because this is the lowest frequency readily convertible to the 1.95 megacycle frequency used in loran on channel 1. A higher frequency is not employed since above 175 kc the attenuation of sound waves in air becomes excessive even over short distances. The time base characteristics are identical insofar as repetition rates and frequency stability is concerned. The actual loran transmitters are replaced by ultrasonic transducers from which emanate pulse-modulated signals. These signals radiated over the scale area of the trainer table are picked up by means of an ultrasonic receiver called the mobile transducer, which actually represents the antenna of the aircraft or ship and performs the additional function of converting the ultrasonic energy to electrical energy which is subsequently fed into electronic gear to be described later. The mobile transducer is attached to a triangular shaped carriage or "crab" which represents the actual aircraft or ship. Through a unique electromechanical device the speed and heading of the crab can be controlled accurately by the instructor and can be made to "fly" over any predetermined course. The electrical impulses from the mobile transducer at the carrier frequency of 175 kc are converted to 1950 kc—channel 1 in the loran system—by the amplifier-converter, and then fed simultaneously into a radiating antenna and a monitor receiving set. The radiated signal is

picked up by students with their respective loran receiving sets. The block diagram for the complete trainer is shown in *Fig.* 3.

#### The Transmitter Channel

To make for a clearer understanding of the operation of the Loran Trainer, it is convenient to divide the trainer into two major channels: the transmitting channel, and the receiving channel. The components in each will be taken up briefly in turn.

*Figure* 4 is the block diagram for the crystal timer. The purpose of this unit is to generate the basic timing pulses which are used to obtain the 25- and 33 1/3-cps pulses which drive the ultrasonic transmitting transducers. Fundamentally, the timer consists of a crystal-controlled oscillator which produces sine wave output at 100 kc, a buffer amplifier whose primary function is to isolate the oscillator from the first counter circuit, a 5:1 frequency divider; and two cathode followers which act as low-impedance output couplers. Two output signals are taken from the crystal timer unit—a 50-μsec signal (one pulse every 50 μsec, or

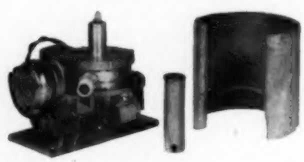


**Fig. 7. Transmitting transducer with acoustic shield and projector lens removed to show splitting vanes.**

20,000 pulses per second, pps) and a 10-μsec signal (one pulse every 10 μsec, or 100,000 pps).

Master Timers A and B, *Fig.* 5, are identical. To simplify analysis, the master timer may be divided into four main sections. The first or counter section consists of the 2nd, 3rd, 4th, 5th, and 6th counters which act as a series of frequency dividers; the second section consists of the station selector which changes the total frequency division of the counters in small increments to give the proper recurrence rates for the various pairs of stations. The third section is composed of the square-wave generator which is controlled by the output signals of the 6th counter-oscillator. The function of this generator is to produce square waves at half the frequency of the pulses at the output of the 6th counter oscillator. The square waves formed at one plate of the generator are differentiated to form sharp pulses which are fed into the delayed output. The square waves formed at the other plate pass through a second differentiator and the pulses thus formed are used to initiate the 500-μsec delay multivibrator. The fourth or delay section consists of a series of multivibrators which provide a minimum of 760 and a maximum of approximately 11,000 μsec additional delay between the two pulses from the square wave generator. Signals from the delay

circuits are fed into the delayed output follower.

The Switch Assembly unit provides a means of connecting the various outputs of the master timers to the inputs of the crystal transducer driver and provides direct access to test points in all timer units. It serves as a patch panel to facilitate connection to the video input of the loran indicator.

*Figure* 6 is the block diagram for the Crystal Transducer Driver which is made up of three identical sections on one chassis. Each section is used to supply the pulse-modulated signal required to operate one of the crystal transducers at the carrier frequency of 175 kc. Each complete driver section consists of: an inverter-amplifier which amplifies and inverts the incoming positive pulses from the master timers; a pulse-length multivibrator which varies the length of the pulse obtained from the inverter amplifier; an oscillator gate which modulates the oscillator at proper intervals (25 or 33 1/3 cps); an oscillator which operates at 175 kc; a voltage amplifier; and a cathode follower which provides a low-impedance source for the power amplifier which drives the crystal transducer.

The Transmitting Crystal Transducer, *Fig. 7* is actually the heart of the ultrasonic end of the trainer since its function is to convert the pulse-modulated 175-kc electrical input to ultrasonic wave trains. The transducer radiates these ultrasonic waves throughout a spherical section 270 deg. in azimuth and 45 deg. in altitude. The radiation in altitude is used to simulate sky-wave transmission in conjunction with an artificial glass ionosphere mounted above the operating table. Provision is also made to simulate sky-wave "splitting," a super-

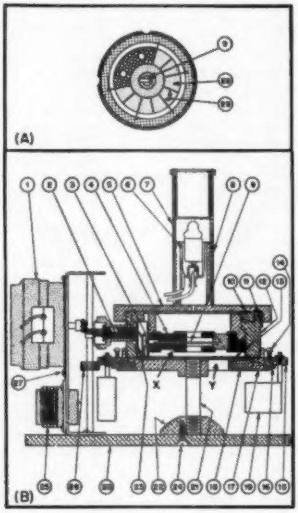



**Fig. 8. (A) Plan view of crystal assembly in transducers, and (B) cross section of transmitting transducer.**

position of reflections from two adjacent layers of the ionosphere. This is done by a series of vanes mounted on a geared ring which revolves about the transducer shell. How this splitting of sky waves actually occurs is explained later.

### General Construction

In *Fig.* 8, (B) shows a section through a transmitting transducer, which consists of a cylindrical metal shell (*12*) sealed at one end by a thin aluminum diaphragm (*13*) and covered at the other end by a metal cap (*5*). Mounted concentrically inside the shell is a crystal assembly (*4*) which can be raised or lowered by means of a tuning ring (*10*) so that the space (X) between the bottom of the crystal assembly and the top of the diaphragm can be varied. The diaphragm is held in place by a clamping plate (*18*) from which a section (Y) having the shape of the crystal group is removed. Electrical connection is made to the crystal group through the inner electrode (*9*) and outer electrode (*2*) by means of the spring contacts (*3*) soldered to the ends of each electrode. A geared splitting ring (*15*) supports the splitting vanes (*19*). The teeth on the periphery of the ring engage with a spur gear (*26*) so that the ring is revolved slowly about the transducer by the motor (*1*). The height of the splitting ring can be adjusted slightly by the three screws (*14*). These screws raise or lower the seat (*17*) on which the ring rests. The transducer assembly is supported by a post (*21*) screwed into a reflecting cone (*22*) which in turn is fastened to a base plate (*20*). A lamp assembly (*6*) and light projection system (*7*) is mounted on the cap of the transducer. A top view of the crystal assembly is shown at (A) in *Fig.* 8. The crystal element is made up of a group of eight keystone-shaped crystals (*28*) so arranged in doughnut form that vertical faces of like polarity are adjacent. Thin foil strips (*29*) are cemented to the vertical faces of the crystals and strips of like polarity are soldered to the inner electrode while those of opposite polarity make contact with the transducer shell. The eight crystals are thus connected in parallel across the energizing voltage.

### Theory of Operation

In its task of converting electrical to ultrasonic energy, the transducer makes use of the piezo-electric effect of the eight keystone-shaped X-cut Rochelle salts crystals (*28*).

Damping is required in order to eliminate spurious and unwanted oscillations in the crystals when they are shock excited by pulses with relatively steep wave fronts such as are used in the trainer. Another and important effect of undamped crystals is to lengthen the effective length of the pulse applied to the input of the transducer. The simplest method of mechanical damping is to immerse the crystals in a liquid.

Since Rochelle salt is soluble in water, it is necessary to use a liquid other than water. With few exceptions most liquids have similar acoustical qualities. Purified castor oil proves to be an excellent

damping agent and since it has good electrical properties as well, it is employed in the transducer. In this application the entire crystal is covered with castor oil, covering the top surface where the damping action is required. The space between the crystals and the aluminum diaphragm is therefore filled with castor oil. The mode of vibration of the crystals is primarily in a vertical plane so that the sound waves must pass through the oil before reaching the air. The general effect of such an intermediate layer is described in any standard acoustics text. Briefly, the effect is twofold. First, the high acoustic impedance of oil as compared to air introduces a considerable increase in damping of the oscillations of the crystals. Second, since castor oil has an acoustic impedance which is intermediate between that of the crystal and that of air, the acoustical match between the crystal and air is improved if the thickness of the intermediate oil layer is approximately one quarter wave length in oil. The wave length of sound in oil at 175 kc is approximately 8.0 mm and consequently 2 mm (1/4 wave length) turns out to be the thickness of the oil layer required to produce a satisfactory compromise between damping and matching.

The importance of providing a means to simulate the effect of ground and sky wave transmission into the trainer will be covered in the concluding article of this series, which will appear next month. The receiving channel will be described fully, and the method of overall operation explained.

(*To be concluded*)

## IMPROVED BASS RESPONSE

[*from page 18*]

cps, resulting in a disagreeable boominess characteristic of commercial radio sets, juke-boxes and the like. As shown in curve (D), attenuation below resonance is at the usual rate of 12 db per octave plus 6 db per octave due to the "doublet" or phasing out effect of the back radiation. In general, any open-back box is considerably improved by closing off the rear.

### The Enclosed Box

The simplest form of good speaker enclosure is the enclosed box, with the only energy radiated into the listening area being from the front, as in the case of the infinite baffle. The chief difference between this enclosure and the infinite baffle is that the capacitive load on the back of the cone increases the stiffness of the suspension system, raising the mechanical resonance. This causes the usual attenuation of 12 db per octave to start at a higher frequency. Curve (E) shows that the level just before attenuation is higher, or peaked. This is true because the cone mass is resonating with the low compliant mass within the cabinet. When this peak is objectionably high, holes, or acoustic resistances in

the back side of the cabinet will lower the peak, and consequently extend the bass range with another smaller peak before violent attenuation sets in.

Reflections with attendant reinforcements and cancellations within the box occur from about the fourth or fifth octave on up. These can be minimized with sound absorbent material generously applied to opposing surfaces.

#### Reflex Boxes

The currently popular vented enclosure utilizes a novel method of raising efficiencies in the last part of the 3rd octave around 100–130 cps. The front port, or vent, is tuned to allow for a delay of the back radiation. This permits an in-phase relationship resulting in a reinforcement just below the peak caused by resonance of the cone in conjunction with the true box resonance. Curve (F) indicates results to be expected with enclosures of the same relative size, approximately 7 cubic feet. Observe that attenuation past resonance is 18 db per octave versus 12 db per octave in the completely closed box. All other factors being equal, the range is not as great as the closed box. The peaks are higher and the valleys lower. Moreover, the characteristic boominess is objectionable to the discerning listener. But the fact remains that the added efficiency, in the more restricted spectrum that it does reproduce, finds considerable favor.

It is recommended as a guide that no less than 6 cubic feet be considered for satisfactory results. The depth of the box should be about one-half the length or height. Although formulas exist for computing the port size, the necessary data on cone weights, compliance, cone resonance, and other parameters are seldom available to the constructor. The most practical and by far the most accurate method of determining optimum port size in a specific box for a particular speaker is the procedure as follows:

Place a voltmeter across the voice coil and start with a port of about 150 square inches. Scan the first three octaves with an audio oscillator playing through the speaker system, gradually decreasing the port size until two peaks are observed in the reading of the highest intensities and at the lowest frequencies possible.

As a guide to the optimum box size for top results with a speaker of given diameter, see *Fig.* 3. Note that for the best results—insofar as extended bass reproduction is concerned in a medium size cabinet, (say up to 12 cubic feet)—the 12-in. cone has a considerable edge over the 15-in. model. The low-frequency driver of 18 in. is impractical and almost unuseable unless the volumetric capacity of the box is very large, or over 20 cubic feet.

#### Recapitulation

A study of the comparative designs offered above suggests that a rather poor job of bass reproduction is being effected unless large cavities, of the order of 12 cubic feet on up, are considered. The infinite baffle, combined with a cone resonance of 40–45 cps, does by far the best job if it is feasible to employ it. The vented box lends a "muddy" quality to the music and restricts the range, but is generally preferred over the plain closed box of equal size in spite of the added purity and extended range of the latter. This can be explained by reason of the foremost requirement of efficiency for the bass, even if of more restricted range.

Of the utmost importance in any of the designs above is low cone resonance, which also involves high compliances, or values of *C* in the equivalent circuit.

#### Towards Better Bass Response

*Theater Horns*—With space not being a limiting factor, the folded theater horn, is preferred. Response with this almost ideal enclosure is flat to 50 cps. Below this point, attenuation is fairly rapid. However, this horn delivers the smoothest, distortion-free response down to 50 cps that the art has been able to develop. The difficulty presented otherwise by this system is the need for dual drivers, and the requirement for a rather expensive cellular horn and treble driver above 400 cps. Observe the very low portion of the curve for this unit, shown in *Fig.* 6 with the curves of a number of commercial enclosures. This curve shows what can be done by enclosing the backs of the drivers with a cavity of about 16,000 cu. in. If the Klipsch-type units with high compliances are employed, it is possible to resonate this back cavity with the frontal air load mass and achieve added response down to 30 cps.

The vast majority of living rooms, however, have no provision for a system approaching the size of this rather ungainly device. The basic principles can be adapted, however, as disclosed in the more practical enclosures to follow.

#### Corner Designs

As a rule folded horns are recommended for operation only up to 400 cps. At almost 500 cps and up, the higher frequencies find difficulty in following the circuitous path, ***unless supplemented by front radiation*** from the bass driver cone.

In several E-V designs, the folded horn loading is actuated from the rear of the cone while radiation of the higher frequencies takes place equally from the front. The important cavity directly behind the cone acts as an acoustic low-pass filter below 200 cps. This filter prevents phasing out of the front radiation by the back waves above this point. Some interference is measurable below 200 cps, but the generally smooth response to 65 cps overwhelmingly justifies the design. The sides of the room provide additional loading, acting as an extension of the mouth of the horn. This assists further in the formation of a spherical wave shape which promotes easy listening. Some radiation is effected, just barely useable, at 30 to 45 cps. The corner design proves itself an excellent substitute for the C-5 bin

where the larger space required is not available.

### Completely Horn Loaded Corner Design

The "Patrician" 4-way system employs a fully horn-loaded driver for utmost purity and efficiency, as shown in *Fig. 7*. In addition, the feature of resonating the back cavity with the front air load mass is utilized. The complete assembly is slightly less than 30-in. deep, allowing it to pass through a standard door.

To insure optimum results the bass horn design is slanted towards the lowest part of the spectrum, and a crossover at 220 cps transfers the task of reproducing the 200–600 cps range to a 12-in. low-frequency unit with an independent horn. To maintain optimum throat-to-mouth relationships, part of the face of each driver is masked off to the proper size. Closing down these throats effects attenuation only of the higher frequencies, well beyond the pass band of these two units. From 600 to 3500 cps, the treble driver exhausts through the large 2 × 5 horn. High-end attenuation for this unit is only 6 db per octave above 3500 cps. This allows a reinforcement in combination with the small Model T-10 super-tweeter of the critical 5000-cps band which so vitally effects the "presence" quality. Dramatic increase in total apparent efficiency is achieved with a 4 to 6 db rise at this particular point. The T-10 Sonax Driver carries the high end through 16,000 cps.

The back cavity of the large driver comprises some 8000 cu. in. to match the high compliance of the 18-in. cone. Note that the small triangular cavities, four in all, are fed to the larger area behind the cone by notches. This makes use of all the space in the bass section. It is essential that the back cavity be absolutely airtight. Horn assemblies are tested in production with a pressure gauge for leaks. The equivalent of a ½" hole will raise the lowest radiation peak by almost 5 cps. Moreover, the driver itself is sealed from front to back with a solid dome, incorporating no "breather."

The impedance characteristic of a loudspeaker rises at the extremes of the spectrum. To more nearly match a 16-ohm crossover network at the very low frequencies, the special Klipsch-type driver has a d.c. voice-coil resistance of only 3.2 ohms, as opposed to the usual resistance of 11.6 ohms in a more conventional unit.

In listening to this system some rather startling effects are observed. When live tape is used as a source, it is possible for the spatial effect of the recording locale to be unconsciously evaluated, contributing materially to the illusion of reality. This is effected through the reproduction of extreme low-frequency effects, such as very low room noises and air rumble, more frequently felt rather than heard. Because all four drivers are loaded with columns of air, diaphragm excursions are held to a minimum, assuring high damping of the voice coils in the densest flux areas, and the smaller excursions minimize diaphragm breakup. Perhaps the most important observation is a negative one—the lessening of listener fatigue. This contribution may be ascribed principally to the elimination of harmonic distortion through the multiple division of the spectrum by disparate drivers.

### Summary

Bass response in currently available loudspeaker systems and enclosures is poor. By considering the spatial requirements and utilizing the corner of the room as an extension of the necessary air-load on the driver cone a considerable improvement in bass range and efficiency can be achieved.

Though the foregoing offers no complete solution to the perfect reproduction of the first three bass octaves, it is felt that perhaps an important improvement of at least 100 per cent is offered from the standpoint of range extension. Efficiencies are improved greatly.

Improvements resulting from the horn load are an appreciable decrease in diaphragm excursions, with correspondingly greater power handling capacity of the driver, decreased intermodulation distortion, and vastly improved transient response.

Subjectively, it is found that apparent gains in realistic reproduction are considerably greater than the bare mathematics would indicate. The masking effect of the more adequate bass prevents extended high response from seeming shrill and thin. The resulting tonal balance achieves a more adequate feeling of listening satisfaction.

## NEW LITERATURE

• **Office of Technical Services,** U. S. Department of Commerce, Washington 25, D. C. is now releasing to the general public a 300-page illustrated report titled "Electronic Equipment Construction — New Objectives, New Techniques and New Components." Prepared by the Standard Research Institute and intended originally as an investigation of the means for minimizing maintenance of military electronic equipment, the report has been expanded to its present scope to meet the demand of the civilian electronics field. Of particular interest is a section in which the current research and development needs of the electronics field are summarized. Price is $7.00; checks should be made payable to the Treasurer of the United States.

• **Cinema Engineering Co.,** 1510 Verdugo Ave., Burbank, Calif. has recently published Catalog 11-AY, a listing of jacks and other accessory equipment including the new Type 4137-B orthacoustic equalizer.

• **Thomas A. Edison, Inc.,** 511 Lakeside Ave., West Orange N. J. is now distributing a handsomely-produced and illustrated 12-page booklet describing the company's new Televoice system for remote control dictation. The Televoice system cuts dictation costs by making use of one to twenty telephone-like instruments wired to a central recording device.

• **Cannon Electric Development Company,** 3209 Humboldt St., Los Angeles 31, Calif. has available a four-page bulletin illustrating and describing its new line of hermetically-sealed plugs for aircraft relays and other sealed components. Requests should specify Bulletin RS-1.

• **Commodity Research Bureau,** 82 Beaver St., New York 5, N. Y. is now publishing a 32-page handbook on Social Security benefits, for distribution by companies to their employees. A sliding scale of quantity prices, based on the number of copies ordered, brings the average wholesale price to approximately 15 cents per copy.

• **Ductone Company,** Keyport, N. J., is distributing to jobbers and dealers a new complete needle guide. Lists all standard makes of record players and the correct stylus for each. Both needles and cartridges are clearly illustrated to simplify selection. Free wall-chart size will be mailed on request.

# CLASSIFIED

**Rates: 10¢ per word per insertion for noncommercial advertisements; 25¢ per word for commercial advertisements. Rates are net, and no discounts will be allowed. Copy must be accompanied by remittance in full, and must reach the New York office by the first of the month preceding the date of issue.**

FOR SALE: Speaker and amplifier. Bozak 201 Kettle Drum, net $115, sell for $85; Brook 10C3 with preamp, net $315, sell for $245; used less than 500 hours; demonstration in Washington (D. C.) area. Both for $310. Box CN-1, AUDIO ENGINEERING.

FOR SALE: 1 UPA-004 GE tone arm; 2 DL-1RM-6C GE cartridges, .003 used as demonstrators; 1 RPX-041 GE cartridge, .001, new; 1 FP-8 Astatic tone arm and crystal cartridge; 1 E4P Astatic equalizer; 1 CGE-1 UTC equalizer; 1 VI-C15 UTC variable inductor; Amphenol Connectors, one each: 79-06F1, 79-P06M, 79-P06F, 79-06M, 79-08F1, 79-P08M, 91-MC4F1, 92-C1, 92-F1; Tubes, all new, some not in original cartons, standard brands: 1-1v, 3-6C6, 4-6C8G, 2-7C4, 1-7E5, 1-7E6, 5-12A6GT, 1-14N7, 1-14W7, 1-28D7, 1-36, 2-39, 1-55, 1-56, 1-58, 2-82, 1-85. Make offer for the lot. Curtis Radio Service, Box 266, Enterprise, Ore.

WANTED: Used Laboratory-type test equipment; Audio oscillator, A.C. Voltmeter, VTVM, Oscilloscope, etc. Gallant Engineering Company, 261 Constitution Ave., N.W., Washington 1, D. C.

WANTED: N. Y. tape hobbyist lucky with "Gotterdammerung" broadcast, Feb. 17, who may want to copy another broadcast or would accept copying fee. Box CN-2, AUDIO ENGINEERING.

PURCHASED six months ago, perfect condition: Altec Lansing 604B speaker $125, original cost $159. Also Newcomb HLP-14 amplifier $50, original cost $84. Tony Hofmann, 11 Shady Hill Square, Cambridge, Mass.

UNIQUE opportunity: Disposing superb custom audio outfit: Klipschorn, Brook, Browning, Rek-O-Kut (hysteresis), Pickering arm, diamonds, in tawny mahogany cabinets. Phone CH 2-7762 or write Elliott, 9 Charlton St., New York 14, N. Y.

FOR SALE: All new, in original boxes, Cornell-Dubilier noise filters: 1 1F-7A, 2 1F-18, 2 1F-21, 1 1F19, 3 1F-22BB, 3 1F-22AB, 2 1F-20, 9 1F-6, Miller noise filters: 2-7875, 5-7804, 3-7803. Make offer for the lot. Curtis Radio Service, Box 266, Enterprise, Ore.

PRESTO 90-A amplifier: three mike inputs, switch for continuous and simultaneous record, high and low boost, 78 rpm, NAB record and playback, P.A., Phono, line recording, $250.00. Brush three-hour wire recorder, 50-8000 cps with extras $175.00. Reco-Art, 1305 Market Street, Philadelphia, Penna.

FOR SALE: Altec Lansing 605A speaker with dividing network, mounted in a Cameron Craft Blond Oak cabinet, $190. 2 Rek-O-Kut G2 standard, $75 each, including two Brush PL-20 arms. Entire lot for $325. James E. Palmer, 3095 36th Place, Sandia Base, Albuquerque, N. M.



## I. R. E. SHOW

[*from page 23*]

sis on laboratory test equipment. Design and development engineers, in particular, indicated keen interest in various types of Browning oscillo-synchroscopes. Latest models of Browning FM and AM-FM tuners were on display, though not as prominently as test instruments.

**Federated Purchaser, Inc.**, although showing a variety of equipment, devoted the bulk of its space to a display of the names of manufacturers whose products the company handles, and to a series of mural-type photographs of its lavish new showroom in downtown New York. Interesting to note that, although the IRE show is general in character, jobbers and distributors who used their facilities to exhibit saleable items, displayed more audio components than all other types of equipment combined.

Federated Purchaser, Inc.

**Federal Telecommunication Laboratories** emphasized the diversity of its manufacturing facilities with a display embracing an impressive variety of electronic components. Foremost among the items featured was a flying-spot scanner, offered as a means of improving efficiency, at the same time reducing cost, of TV station operation. It affords a wide variety of effects such as laps, dissolves, fades, etc., and requires only one operator.


Federal Telephone & Radio Corporation

—*H. K. R.*

AUDIO engineering society

Containing the Activities and Papers of the Society, and published monthly as a part of AUDIO ENGINEERING Magazine

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Audio Engineering Society, Box F, Oceanside, N. Y.

# NBC-Sponsored Unit Assigned Active Duty

The mobile radio broadcasting company, part of the Army's Organized Reserve, which has been sponsored by the National Broadcasting Company through the Department of the Army's Industrial Affiliation Program, was scheduled at the time this was written to enter active military service May 1, 1951. Its recent activities have been supervised by Major General George L. VanDeusen (Retired), president of RCA Institutes.

The unit is composed chiefly of personnel from NBC and from RCA Institutes. The bulk of these men are specialists in some phase of broadcast communications or pogramming. The unit is part of a larger organization, which will operate as a psychological warfare group. The commander of the group is Col. Ellsworth H. Gruber of the New York Daily News.

Primary mission of the unit will be mobile radio broadcasting for psychological warfare purposes. The men in the unit will be performing essentially the same type of work they did in civilian life, which will be operation of broadcasting studio facilities and high-power transmitters.

The NBC-sponsored unit is commanded by William B. Buschgen, Captain, Signal Corps-USAR, and was organized originally in November, 1948. The regular bi-weekly meetings and technical lectures have been held in NBC's Radio City studios, and other engineeing facilities of the network were made available to the unit.

The unit will receive its initial training at Fort Riley, Kans.

# Section Meeting Reports

| Section | Speaker | Subject | Date |
|---|---|---|---|
| Cincinnati | Dr. Frank McIntosh | Design Considerations of High-Quality Output Transformer for Class $AB_2$ Operation | 11-14-50 |
| Cleveland | H. B. Hoff | Program Circuit Equalization | 1-17-51 |
| Cincinnati | Kenneth Boothe | Use of Tape Recording for Telemetering | 1-25-51 |
| San Francisco | Peter B. George | Architectural Acoustics | 2-12-51 |
| S. Michigan | Howard Souther | High Fidelity Loudspeakers and Enclosures | 2-20-51 |
| Cleveland | Dr. S. J. Begun | Some New Equipment in the Audio Field | 2-21-51 |
| Cleveland | Paul Klipsch | The Klipsch Speaker | 3-5-51 |
| S. Michigan | C. F. Murphy and W. D. Moering | Slow Speed Tape Recording | 3-20-51 |

## Notice

Avoid delays in receiving meeting notices and Society news. Be sure to notify the secretary of any change in your mailing address.

Following are names of members for which we have no current mailing address. Help!

| | |
|---|---|
| Douglas H. Baker | William B. Holleman |
| Norman K. Charland | John Krance |
| Leong J. Chun | Robert L. McKenzie |
| Donald F. Clearly | Bernard J. Migliaro |
| George S. Cohen | M. Madan Mohan |
| Lyle B. Dahms | Frederick J. Retschauer |
| Richard W. Dunham | William H. Rosier |
| Henry J. Haffmans | William L. Terry |

# Employment Register

Positions open and Available personnel may be listed here at no charge to industry or to members of the Society. For insertion in this column, brief announcements should be in the hands of the Secretary, Audio Engineering Society, Box F, Oceanside, N. Y., before the fifth of the month preceding the date of issue.

★ Positions Open ● Positions Wanted

★ **Wanted:** Approximately 250 electronic and electrical engineers, 30 physicists, and 10 technical writers to staff seven new plants of Westinghouse Electric Corporation. Permanent positions with assured future. Preference for men with minimum of two years experience in research, design or development. Salaries based on experience and ability. Interested engineers should get in touch with nearest Westinghouse office for confidential interview.

★ **Wanted:** Sylvania Electric has openings for engineers and physicists in all phases of electronic research, design, development, and application. These are permanent positions in a rapidly expanding program, and offer excellent growth possibilities. Several locations. For further information send resume or inquiry to D. W. Currier, Sylvania Electric Products, Inc., 1740 Broadway, New York 17, N. Y.

## FILTER DESIGN

[*from page 28*]

$$\therefore \quad L_2 = \frac{12.4}{12}(0.954) = 0.958 \text{ h.}$$

$$C_2 = \frac{12}{12.4}(0.0066) = 0.0064 \ \mu\text{f.}$$

$$X_{L_2} = X_{C_2} = \left(\frac{1-m^2}{2}\right)(Q_oR_o)$$

$$\times \left[1 + \left(\frac{f_{\infty}}{f_o}\right)^2\right] = 13{,}250 \text{ ohms}$$

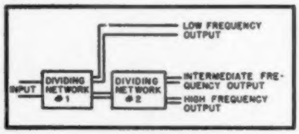



**Fig. 11. Block diagram of three-way dividing network.**

$$\therefore \quad L_3 = \frac{13.25}{12}(0.954) = 1.05 \text{ h.}$$

$$C_3 = \frac{12}{13.25}(0.0066) = 0.006 \ \mu\text{f.}$$

The simplified design of filter elements constitutes only a partial solution of the filter problem. The insertion loss of individual and composite sections usually is the desired criterion.[2] Many articles have been written on the design of filter type dividing networks. The element values for these networks also may be designed using the simple methods described. For example, a three-way network[3] may be evolved by noting that it is composed of two separate dividing networks, as shown in *Fig.* 11. The reactances of the elements are determined by applying the theory of fractional or $x$ termination[4] whereby series elements $Z_{cd}$ in the low-pass filter may be omitted because they are represented to a good approximation by portion $Z_{CD}$ of the high-pass filter for frequencies in the stop band region of the high-pass filter. Similarly, the series elements $Z_{ab}$ of the high-pass filter may be omitted since they are represented in the circuit by the portion $Z_{AB}$ of the low-pass filter for frequencies in the stop band region of the low-pass filter, as illustrated in *Fig.* 12, (A) and (B). The element values and the complete circuit of the Douglas three-way network are reproduced at (C).

#### Conclusions

In summary, it has been shown that elements of the major high-pass and low-pass filter types may be determined rapidly by letting $R_o$ equal the reactance of each half-section element at cut off. Elements of band-pass and band-elimination filters are found by letting $Q_oR_o$ equal the reactance of each element of the series resonant branches at center frequency, the parallel branch elements being the inverse of the series branch elements. T-sections are formed by paralleling the pillars of two L sections, while Pi sections are formed by joining the series arms of two L sections.

[2] Useful practical curves for this purpose appear in "Simplified Filter Design" by J. Ernest Smith, pub. by *RCA Review*, Princeton, N. J.

[3] As suggested by George A. Douglas in "Three-way speaker system", AUDIO ENGINEERING, June 1948, page 15.

[4] Radio Engineer's Handbook, F. E. Terman, 1943 ed. p. 237.

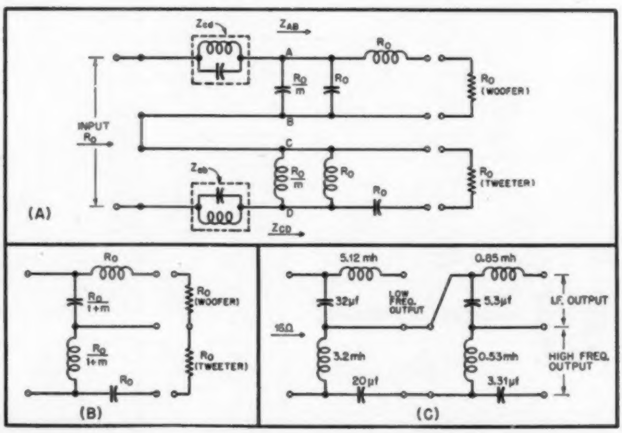



**Fig. 12. (A) Evolution of a filter-type dividing network. The dotted networks are omitted when the two filters are series connected. (B) Reactance values of the elements of a two-way filter-type dividing network at crossover network. (C) 12-db per octave three-way dividing network showing element values. The crossover frequencies are 497 and 3000 cps.**

**SUBSCRIBERS—**

Occasional delays in receipt of the issues of AUDIO ENGINEERING have been reported to the Circulation Dept. Mailing is normally completed each month by the 3rd, and reasonable time should be allowed for your copy to reach you before writing.



# Industry Notes--

**Federated Purchaser Inc.,** 66 Dey St., New York City, will become nation's first coast-to-coast electronics distributor with opening of its fifth store, located at 911 S. Grand Ave. in Los Angeles wholesale district. New location will serve Pacific Coast, Northwest and Southwest. . . . **Globe-Union Inc.,** 900 E. Keefe Ave., Milwaukee 1, Wis., has purchased a building providing 158,000 sq. ft. of manufacturing space for use by company's **Centralab Electronics Division**—full occupancy planned for August 1 with 800 employees. . . .

**Pacific Electronic Exhibit** and Western meeting of IRE dates changed to August 22-24—location is Civic Auditorium in San Francisco. . . . **Federal Telephone and Radio Corporation,** Clifton, N. J., announces completion of 450-mile three-channel carrier-telephone system extending from Independence, Kans., headquarters of **Sinclair Pipe Line Company** to division office in Ft. Worth, Tex. . . . **Tetrad Company, Inc.,** 4921 Exposition Blvd., Los Angeles 16, Calif., has expanded into production of miniature and subminiature transformers meeting JAN and MIL spes. . . .

**Westinghouse Television and Radio Division,** Sunbury, Pa., awarded four contracts totalling $12 million for manufacture of electronic equipment for Armed Forces—production of TV receivers will not be affected for time being. . . . **Cannon Electric Co.,** 3209 Humboldt St., Los Angeles 31, Calif., has opened a new plant in New Haven, Conn., to provide design consultation service for Eastern customers—assembly and manufacturing facilities are planned soon. . . . **Hytron Radio and Electronics Corp.** and subsidiaries, including **Air King Products Co.,** in process of being sold to **Columbia Broadcasting System** for $20 million. . . .

**Sylvania Electric Products** planning new factory in Burlington, Ia., to cost $1.5 million and employ 800—this will be company's second plant west of Mississippi, other being in Shawnee, Okla. . . . **NBC** making experimental use of new parabolic-type microphone said to afford high-quality pickups from distances up to 35 feet—called "The Big Ear." . . . **Milo Radio & Electronics Corp.** has installed teletype to permit more rapid contact with both suppliers and customers.

# Industry People--

**John S. Boyers,** chief engineer and assistant treasurer since 1946, has been elected president of Magnecord, Inc. . . . **Leon Wortman,** formerly with Fairchild, appointed director of advertising and sales promotion for Audio & Video Products Corporation. . . . **Louis H. Niemann,** manager of sales engineering for tube division of Sylvania, on leave to serve as chief of NPA's Electron Tube Section. . . . **John K. Hilliard,** Altec-Lansing's chief engineer, in Europe for extensive study of foreign production and engineering in the sound equipment field. . . .

**R. J. Neubecker,** formerly with Union Carbide and Carbon Corp. chosen to head Defense Division of American Molding Powder and Chemical Corp. . . . **Robert T. Eakin** completes Horatio-Alger rise from student engineer to manager of Allegheny Ludlum Steel Corporation's largest plant. Only 35, he joined company in 1940. Succeeds **George Evans,** who remains as special consultant to vice-president in charge of operations. . . . **Arthur Priest** preparing new Sound Equipment Catalog for Leonard Radio, Inc.

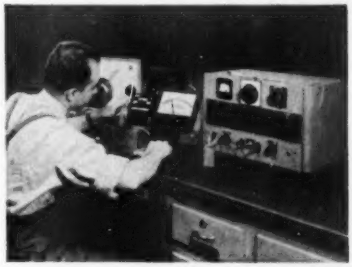
## ADVERTISING INDEX

•

# PRECISION IN PRODUCTION

**Many people realize and take advantage of the fact that "the tough ones go to UTC." Many of these "tough ones," while requiring laboratory precision, are actually production in quantity. To take care of such special requirements, the UTC Laboratories have a special section which develops and produces production test equipment of laboratory accuracy. The few illustrations below indicate some of these tests as applied to a group of units used by one of our customers in one production item of equipment:**

The component being checked here is a dual saturable reactor where the test and adjusting conditions necessitate uniformity of the complete *slope* of the saturation curve. The precision of this equipment permits measuring five widely separated points on the saturation curve with saturating DC controllable to .5% and inductance to .5%.



Servomechanisms and similar apparatus depend, to a considerable degree, on phase angle operation. The transformer adjusted in this operation requires an accuracy of .05 degrees phase angle calibration under the resonant condition of application. With wide change in voltage and temperature range from −40 to +85 degrees C., the phase angle deviation cannot exceed .2 degree. To effect this type of stability, specific temperature cycling and aging methods have been developed so that permanent stability is effected.

This test position involves two practical problems in a precision inductor. The unit shown is adjusted to an inductance accuracy of .3%, with precise (high) Q limits. It is then oriented in its case, using a test setup which simulates the actual final equipment so that minimum inductive coupling will result when installed in the final equipment.

The hermetic sealing of transformers involves considerable precision in manufacturing processes and materials. To assure consistent performance, continuous sampling of production is run through fully automatic temperature and humidity cycling apparatus. It is this type of continual production check that brings the bulk of hermetic sealed transformers to UTC.


150 VARICK STREET NEW YORK 13, N. Y.
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• Standard plug-in mounting—for new handling convenience
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• Noise level—down 83 db at verge of limiting
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Save yourself hundreds of dollars when you buy your limiting amplifier. Specify a BA-6A. For complete details, call your RCA Broadcast Sales Engineer. Or write Dept. PA-19, RCA Engineering Products, Camden, N. J.
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